Difficult airway management and training: simulation, communication, and feedback

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Purpose of review

Successful and sustainable training and learning of the management of difficult and normal airway is essential for all clinically active anesthesiologists. We emphasize the importance of a continuously updated learning and training environment based on actual knowledge, best available equipment, standardized procedures, and educational theory.

Recent findings

In the past, most of the training were based on 'learning by doing' under the supervision of superiors or experienced colleagues. This has been recognized as insufficient and training has evolved to its recent level by structuring it into technical, methodological, and behavioral components. Additionally, a large part of it has been shifted away from learning on patients to simulated scenarios in designated environments. The contents, structure, components, and succession of components have been refined according to the steadily evolving and available instruments. Increasingly, team interaction and behavioral aspects gained more attention and became part of standardized education units that are tailored to the learners' clinical role and level of experience.

Summary

We present the details of the Zurich Airway Training and Simulation program, which has been constantly updated to the actual state of knowledge and available equipment.

Keywords

airway management, behavior, education, feedback, simulation, training

INTRODUCTION

Securing the airway during general anesthesia has become a cornerstone of clinical practice. The risks involved in losing control over ventilation and gas exchange are associated with the most severe and rapidly evolving complications during anesthesia [1]. Training in management of the airway, notably of both, the normal and the difficult one, has received much attention in any professional curricula and became the subject of various guidelines. Therefore, it justifiably occupies a large part of education and training of anesthesia personnel [2].

Airway management training should happen on various training categories and levels such as in institutional lectures, hands-on workshops, behavioral, formal and informal training as well as acquiring of bedside experience in real cases under the supervision of suitably competent mentors, as well as the development of the respective instructor faculty. However, not all this might be enough. Since difficult airway situations may happen unexpectedly, are relatively rare and may have diverse causes, appearances and degrees of difficulty, a realistic but yet hazard-free environment for training such situations is of great value. Therefore, simulation-based education (SBE) is viewed as an important and integral part of anesthesia training [3,4▪,5,6▪,7▪]. This applies specifically not only for novices, but it remains a lifelong task even for the most experienced professionals: the variety and ever changing appearance of airway problems as well as the continuous development of airway devices and technical solutions actually oblige everybody to perform regular training units in a simulated environment.

In addition to the educational benefits, the continuous appearance of new devices and gadgets as well as the evolutionary optimization of techniques

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KEY POINTS

- To acquire and maintain skills of management of the normal and the difficult airway, it is necessary to continuously update knowledge and to train the handling of the best available equipment. These measures encompass mastering standardized procedures according to recent guidelines, and training their application in complex and unexpected situations.
- Airway training is composed by technical, methodological, and behavioral components, which should be taught and rehearsed in dedicated simulation centers before bedside teaching is applied.
- The focus in simulated airway scenarios is to improve team interaction and behavioral aspects as integral parts of standardized education units that are tailored to the learners' clinical role and level of experience.

is one of the driving forces behind the necessity to train airway-related skills via simulation. Another perspective is the behavioral aspect and the interaction between multiple team members that can be systematically trained using SBE. This approach has gained more and more attention [8–12]. However, the handling of selected locally chosen airway instruments is an indispensable prerequisite to simulate more complex scenarios [13–15]. Therefore, in a basic and initial approach, the respective teaching focuses on the correct instruction on how to operate the involved devices. Once the manual aspect is satisfactorily mastered, the behavioral component can be added to subsequent training efforts [16]. This implies that the technical mastering of the airway should remain one of several learning objectives, whereas behavioral aspects of airway management training are another distinct component.

IMPLEMENTATION OF GUIDELINES ON AIRWAY MANAGEMENT

On a worldwide scale, the American Society of Anesthesiologists has published the first guidelines for the management of a difficult airway situation in 1993 [17]. This first version was subsequently updated in 2003 and 2013. Certain other national guidelines for the management of a difficult airway followed suit, and referred to the original American Society of Anesthesiologists guidelines or have integrated parts of it into their own algorithms.

In September 2015, the Difficult Airway Society published new guidelines of the unexpected difficult airway in the *British Journal of Anesthesia* [13] based on literature as on various web pages of the American Society of Anesthesiologists (http://www.asahq.org), Australian and New Zealand College of Anaesthetists (http://www.anzca.edu.au), European Society of Anesthesiologists' (http://www.esahq.org/euroanaesthesia), Canadian Anesthesiologists' Society (http://www.cas.ca), and the Scandinavian Society of Anesthesiology and Intensive Care Medicine (http://ssai.info/guidelines[M2]/).

Following the new Difficult Airway Society Guidelines, in October 2015 the German Society of Anesthesiology and Intensive Care Medicine also published new S1 guidelines on airway management [18]. As such, the new German guidelines reflect the current state of science and integrate currently recommended techniques and strategies. All these guidelines show slightly different approaches for the management and training of the expected and the unexpected difficult airway. Their common denominators are the necessity of prediction and anticipation of airway problems, the absolute priority to maintain oxygenation, the central role of supraglottic airway devices as a transitory or definitive solution for many airway problems, and finally the necessity for the creation of an invasive transtracheal access for oxygen insufflation or ventilation in the 'cannot intubate, cannot ventilate' scenario.

TRAINING UNITS FOR INSTITUTIONALLY INTRODUCED AIRWAY EQUIPMENT

In our institution, we have setup a thorough and multilayered education and training plan, which is exclusively applied and operated by a dedicate team of trained instructors in our Simulation Center. The basic training aims to learn and acquire the necessary technical skills with a standardized subset of airway instruments. In a step-by-step fashion, which is adapted on the individual professional level of expertise, the following airway techniques are demonstrated and trained (Table 1).

Conventional direct laryngoscopy with different blades as well as indirect methods, video-assisted laryngoscopy with different tools (Macintosh video laryngoscope and rigid intubation endoscopes) are trained by the participants on dummies simulating the conventional and difficult airway. Afterwards they can use conventional supraglottic airway devices and flexible intubation endoscopes to train the supraglottic access followed by an infraglottic airway device training (needle and open cricothyreoidotomy). This training would cover all steps of the airway algorithm. However, recent findings show that mere technical training does not prepare the trainees to solve a real difficult airway scenario [19]. Managing a difficult airway requires additional competencies such as situation awareness, communication, leadership, and teamwork [20–22]. Therefore, it is recommended to train the

Table 1. Complete list of techniques incorporated into the Zurich Airway Training and Simulation program with regard of the target population's expertise level

Airway management technique	Expertise level target population	Contents and specifications of the simulation program
Direct laryngoscopy (Macintosh)	Basic beginners <0.5 year	Conventional intubation technique with the curved Macintosh blade No. 3 followed by other sizes for adults
Direct laryngoscopy (with a video laryngoscope of the Macintosh type)	Basic beginners 0.5–1 year	User performs conventional intubation technique with the curved Macintosh blade No. 3 while only the instructor views the video screen
Stylets	Basic beginners 0.5–1 year	Handling malleable stylets in various shapes during direct laryngoscopy (Macintosh type)
Direct laryngoscopy (Miller)	Advanced trainees >1 year	Intubation technique with Miller blades of all sizes for adults
Video laryngoscopy (Macintosh type)	Advanced trainees >1 year, specialists	Video-assisted intubation with the curved Macintosh blade No 3 with User and Instructor viewing the video screen
Direct laryngoscopy (McCoy; Luxamed GmbH & Co. Balubeuren, Germany)	Advanced trainees >1 year, specialists	Intubation technique with McCoy blade No. 3
Video laryngoscopy (angulated type, channeled and unchanneled variants)	Advanced trainees >2 year, specialists	Video-assisted intubation with highly curved (angulated) blades, and with User and Instructor viewing the video screen. Channeled variant without stylet, unchanneled variant with stylet.
Semi-Rigid intubation endoscope (SensaScope; Acutronic Medical Systems, Hirzel, Switzerland)	Advanced trainees >2 year, specialists	Video-assisted intubation with user and instructor viewing the video screen
Flexible intubation endoscopes (Fiberscope)	Advanced trainees >2 year, specialists	Video-assisted intubation with user and instructor viewing the video screen
Supraglottic airway devices (second generation; SAD)	Basic beginners <0.5 year	Straight forward use of Classic (Teleflex, Morrisville, NC, USA) and Proseal LMA (Teleflex, Morrisville, NC, USA) and LMA Supreme (Teleflex, Morrisville, NC, USA)
Supraglottic airway devices (second generation; SAD)	Advanced trainees >2 year, specialists	Extended use of SDA for trans-LMA intubation (Fastrach; Teleflex, Morrisville, NC, USA) with and without assisting with a flexible fiberoptic
Emergency front-of-neck access (cannula techniques)	Advanced trainees >3 year, specialists	Transtracheal puncture in a 'cannot intubate, cannot ventilate' scenario with Narrow cannula and jet insufflation for emergency oxygenation Large bore cannula for emergency oxygenation and ventilation
Emergency front-of-neck access (surgical technique)	Advanced trainees >3 year specialists	Emergency cricothyrodotomy with skin incision and Seldinger technique insertion for emergency oxygenation and ventilation

management of difficult respiratory systems as it would occur in reality, for example, under time pressure, in the presence of interns or residents, with waiting surgeons, and with unforeseen complications, that is, with more complexity than in an individual, standardized training scenario [23].

The technical mastery of different devices alone may not suffice for the effective management of difficult airways; it can be regarded as a necessary but not sufficient condition. Additional training involving human factors and teamwork in complex airway management situations is required for the mastery of airway management, as it is common in other areas of medicine and other industries. For example, in training of complex procedures in aviation, the scenarios are announced to the learners in advance so that they do not have to guess the content of the scenario and can focus on the training of the respective entity [24].

A similar procedure seems useful for training of complex medical algorithms such as the advanced cardiovascular life support and difficult airway management [23]. Therefore, the training of technical devices is followed by a training of using these devices in complex supra and infraglottic airway scenarios.

Learners are staff members of the Institute of Anesthesiology of the University Hospital Zurich who typically perform anesthesia: anesthesiologists (attending and resident physicians) and nurses with a special training in anesthesia. The training takes place in a full-scale-simulator (ALSi, iSimulate, USA and ACL-Trainer Laerdal, Stavanger, Norway) with two scenarios, one dealing with the supra one with the infraglottic airway. The contents of the simulated scenarios is explained in advance and the time for managing each scenario is set to 10 min. After each scenario, a structured debriefing facilitated by an instructor with special training in SBE takes place, which also includes learners who observed but did not actively participate in a respective scenario. During the debriefing, learners receive not only feedback regarding their performance according to the algorithm but also explore reasons for potential deviations from the algorithm. In this way, potentially systematic errors are detected and respective performance gaps closed. Therefore, the combination of technical and nontechnical training of the algorithm for airway management represents a new form of targeted training of anesthesia care providers. A similar approach has been successfully applied in other high-risk industries for years [24].

AIRWAY MANAGEMENT TRAINING METHODOLOGY

In many cases, airway management training is conducted using SBE [3,25]. For adequate education outcomes, SBE was found to be superior to both, no intervention and nonsimulation intervention [4▪]. A recent meta-analysis of 17 studies showed that for airway management training, SBE was associated with improved behavior-related performance as compared with non-SBE training; no differences were found with respect to time to success, technical skill, written examination score, and success rate of procedure completion on patients [7▪]. However, important features of good SBE practice such as the educational model, instructional methods, and feedback were not analyzed.

The Zurich Airway Management Training has just recently been setup. Results from its impact cannot be described yet, but in near future we will introduce assessments of knowledge, clinical, and behavioral performance. However, we view results from education for pediatric resuscitation by simulation and scripted debriefing as seminal examples to be followed in near future [20]. We also intend to apply assessment methods from another investigation, which demonstrated the adherence to algorithm, teamwork, and communication as measured by the Anaesthestist's Non-Technical Skills rating system and by developing a behavioral marker system for use in anesthesia [26].

More comparative studies exploring how to optimize the use of SBE for airway management are necessary.

CRITICAL ASPECTS OF AIRWAY MANAGEMENT TRAINING

Although designing and conducting SBE, attention should be paid to the instructional methods promoting skill acquisition and maintenance to the respective assessment tools [27]. It is also recommended to integrate mechanisms for improving performance, such as briefings and educator-learner communication as early as possible [19,28].

Airway management training, and in particular its technical skills components should follow the basic principles of mastery learning which aims to ensure that learners reach all learning objectives with little or no variation in outcome [29]. The program includes the following components:

Table 2. Mastery learning components of the Zurich Airway Training and Simulation

Mastery learning component	Example of the Zurich Airway Management Training
Baseline assessment	Self-assessment of competence in applying difficult airway management techniques
Explicit learning objectives	Definition of learning objectives based on results of self-assessment
Focused, powerful, and sustained learning activities	Deliberate practice of respective airway management techniques Simulation-based training of applying techniques in complex situations
Minimum passing standard	Unexpected difficult airway can be managed successfully within 10 min
Formative assessment	Feedback Coaching Reflections of skills acquisition and use during debriefing
Summative assessment	Time required for managing difficult airway
Continued practice	Participation in difficult airway management course once a year at minimum; feedback on difficult airway management in the clinical setting

Adapted with permission [23].

baseline assessment; explicit learning objectives which are sequenced as entities with increasing difficulty; engagement in focused, powerful, and sustained learning activities such as deliberate practice [30]; a defined, minimum passing standard for each learning entity; formative assessment with specific feedback supporting completion of the minimum passing standard for mastery of each learning entity; summative assessment, that is, advancement to the next learning entity given measured achievement at or above the mastery standard, and continued practice on a learning entity until the mastery standard is achieved [29]. Respective examples for the Zurich Airway Management Training are shown in Table 2.

CONCLUSION

Successful management of difficult and normal airway is an essential necessity for all clinically active anesthesiologists. Respective training should be continuously updated based on changes in airway management guidelines and advances in educational theory and methods and include the correct conduct of airway management techniques as well as skills for applying them in critical situations (e.g., teamwork). Simulation-based and masterly learning play a crucial role in effective airway management training.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES AND RECOMMENDED READING

Papers of particular interest, published within the annual period of review, have been highlighted as:
- ▪ of special interest
- ▪▪ of outstanding interest

1. Cook TM, MacDougall-Davis SR. Complications and failure of airway management. Br J Anaesth 2012; 109(Suppl 1):i68–i85.
2. Goldmann K, Ferson DZ. Education and training in airway management. Best Pract Res Clin Anaesthesiol 2005; 19:717–732.
3. Barsuk D, Ziv A, Lin G, *et al.* Using advanced simulation for recognition and correction of gaps in airway and breathing management skills in prehospital trauma care. Anesth Analg 2005; 100:803–809.
4. ▪ Kennedy CC, Cannon EK, Warner DO, Cook DA. Advanced airway management simulation training in medical education: a systematic review and meta-analysis. Crit Care Med 2014; 42:42.

This is an important source of information about the baseline and the effects of conventional versus simulation-based airway training.

5. Kory PD, Eisen LA, Adachi M, *et al.* Initial airway management skills of senior residents: simulation training compared with traditional training. Chest 2007; 132:1927–1931.
6. ▪ Schulze M, Grande B, Kolbe M, *et al.* SafAIRway: an airway training for pulmonologists performing a flexible bronchoscopy with nonanesthesiologist administered propofol sedation: a prospective evaluation. Medicine (Baltimore) 2016; 95:e3849.

This is a recent example how we implement simulation-based training for pulmonologists dealing with airway endoscopy.

7. ▪ Sun Y, Pan C, Li T, Gan TJ. Airway management education: simulation based training versus nonsimulation based training-A systematic review and meta-analyses. BMC Anesthesiol 2017; 17:17.

The meta-analysis shows clearly and emphasizes the superiority of simulation-based training versus the conventional one.

8. Cooper JB, Blum RH, Carroll JS, *et al.* Differences in safety climate among hospital anesthesia departments and the effect of a realistic simulation-based training program. Anesth Analg 2008; 106:574–584.
9. Hughes AM, Gregory ME, Joseph DL, *et al.* Saving lives: a meta-analysis of team training in healthcare. J Appl Psychol 2016; 101:1266–1304.
10. Manser T, Harrison TK, Gaba DM, Howard SK. Coordination patterns related to high clinical performance in a simulated anesthetic crisis. Anesth Analg 2009; 108:1606–1615.
11. Salas E, Paige JT, Rosen MA. Creating new realities in healthcare: the status of simulation-based training as a patient safety improvement strategy. BMJ Qual Saf 2013; 22:449–452.
12. Wacker J, Kolbe M. Leadership and teamwork in anesthesia – making use of human factors to improve clinical performance. Trends Anaesth Crit Care 2014; 4:200–205.
13. Frerk C, Mitchell VS, McNarry AF, *et al.,* Difficult Airway Society intubation guidelines working group. Difficult Airway Society 2015 guidelines for management of unanticipated difficult intubation in adults. Br J Anaesth 2015; 115:827–848.
14. Nargozian CD. Simulation and airway-management training. Curr Opin Anaesthesiol 2004; 17:511–512.
15. Yang D, Wei YK, Xue FS. Simulation-based airway management training: application and looking forward. J Anesth 2016; 30:284–289.
16. Cook DA, Hatala R, Brydges R, *et al.* Technology-enhanced simulation for health professions education: a systematic review and meta-analysis. JAMA 2011; 306:978–988.
17. Anonymous. Practice guidelines for management of the difficult airway. A report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Anesthesiology 1993; 78:597–602.
18. Piepho T, Cavus E, Noppens R, *et al.* S1 guidelines on airway management: Guideline of the German Society of Anesthesiology and Intensive Care Medicine. Anaesthesist 2015; 64(Suppl 1):27–40.
19. Grande B, Weiss M, Biro P, *et al.* Ist Reden wichtig? Technisches versus kombiniert technisches /nicht-technisches Atemwegstraining in der Anästhesie und Intensivmedizin. Anästhesiologie Intensivmedizin 2015; 56:5–12.
20. Cheng A, Hunt EA, Donoghue A, *et al.* Examining pediatric resuscitation education using simulation and scripted debriefing: a multicenter randomized trial. JAMA Pediatr 2013; 167:528–536.
21. Kolbe M, Burtscher MJ, Wacker J, *et al.* Speaking up is related to better team performance in simulated anesthesia inductions: an observational study. Anesth Analg 2012; 115:1099–1108.
22. Schmutz J, Manser T. Do team processes really have an effect on clinical performance? A systematic literature review. Br J Anaesth 2013; 110: 529–544.
23. Kolbe M, Grande B. Team coordination during cardiopulmonary resuscitation. J Crit Care 2013; 28:522–523.
24. Anonymous. Lufthansa Aviation Training, Airbus 330 Type Rating Flight Crew Training Synergy. Training Course Syllabus, Document number: 3–6–1121, Process family: 3–6 2017; Type Rating Training Release: Deputy Head of Training 3rd party, Issue: 2, Revision: 01, Effective date: 15 July 2017, Applicable legislation: EASA
25. DeMaria S, Levine A, Petrou P, *et al.* Performance gaps and improvement plans from a 5-hospital simulation programme for anaesthesiology providers: a retrospective study. BMJ Simul Technol Enhanced Learning 2017; 3:37–42.
26. Fletcher G, Flin R, McGeorge P, *et al.* Rating nontechnical skills: developing a behavioural marker system for use in anaesthesia. Cogn Technol Work 2004; 6:165–171.
27. Klotz JJ, Dooley-Hash SL, House JB, Andreatta PB. Pediatric and neonatal intubation training gap analysis: instruction, assessment, and technology. Simul Healthc 2014; 9:377–383.
28. St. Pierre M, Breuer G, Strembski D, *et al.* [Briefing improves the management of a difficult mask ventilation in infants: Simulator study using Web-based decision support]. Anaesthesist 2016; 65:681–689.
29. McGaghie WC, Issenberg SB, Barsuk JH, Wayne DB. A critical review of simulation-based mastery learning with translational outcomes. Med Educ 2014; 48:375–385.
30. Hunt EA, Duval-Arnould JM, Nelson-McMillan KL, *et al.* Pediatric resident resuscitation skills improve after 'rapid cycle deliberate practice' training. Resuscitation 2014; 85:945–951.

