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Video killed the Macintosh star: the definitive risk management experience of E. Profili Hospital in Fabriano on routine pediatric videolaryngoscopy

E. Pisello[1], M. Ciuffreda[2], J. Silvestri[1], L. Brugiaferri[1], S. Sorrenti[1], U.W. Basso[1], D. Galante[3], C. Piangatelli[4]

[1]Specialist trainee in Anaesthesia, Resuscitation, Intensive Care and Pain Management, Università Politecnica delle Marche, Ancona, Italy.
[2]Medical executive, Anaesthesia, Resuscitation, Intensive Care and Pain Management Unit, AST Ancona, Fabriano, Italy.
[3]Medical Director, Anaesthesia, Resuscitation, Intensive Care and Pain Management Unit, Cerignola, Italy.
[4]Medical Director, Anaesthesia, Resuscitation, Intensive Care and Pain Management Unit, AST Ancona, Fabriano, Italy.

Corresponding author: M. Ciuffreda, Medical executive in Anaesthesia, Resuscitation, Intensive Care and Pain Management Unit, AST Ancona, Fabriano, Italy. Email: ciuffredamat@libero.it

Keypoints

1. 30% of anaesthesia-related accidents are caused by difficult airway management; 70% of these accidents result in permanent brain damage or even death. Airway risk management plays an essential role in current anaesthesiological practice.
2. Videolaryngoscopy is considered the main technique to facilitate tracheal intubation and reduce its complications; its shared view promotes teamwork, reducing risks and complications related to ineffective team communication.
3. Videolaryingoscopy has been routine practice in the operating block of Profili Hospital in Fabriano since November 2021. Routinary use of videolaryngoscopy allowed us to encourage and optimise teamwork, including training; to reduce the time spent in the operating room and the use of additional devices for managing difficult airways; to completely decrease clinical risk of difficult intubations, eliminating the impossible ones; to overcome the limits of the Colorado Pediatric Airway Score, a score predicting difficult intubation in children, allowing us to easily manage any unexpected difficult airway; to hypothesize, for the near future, the abandonment of scores and parameters predicting difficult intubation, with huge benefits in terms of time spent on surgical patient preoperative evaluation.

Abstract

Introduction

Airway management in tracheal intubation represents one of the crucial issues in current anaesthesiological practice, in which risk management plays an essential role. At the moment, videolaryngoscopy is considered the main technique to facilitate tracheal intubation and reduce its complications. In the operating block of Profili Hospital in Fabriano videolaryingoscopy has been the routine practice since November 2021.

Objectives

Evaluation of the routine use of videolaryngoscopy as a mitigator of clinical risk and unexpected difficulties occurring during tracheal intubation in the pediatric surgical setting. Comparison between Fremantle Videolaryngoscope Scoring System and the Colorado Pediatric Airway Score, a score predicting difficult intubation in children.

Material and Methods

Preliminary prospective observational study of 137 pediatric patients (aged from 3 to 16 years of age) undergoing

surgery, assessed through the previously mentioned scores and classifications.

Results

First attempt tracheal intubation achieved in 95,62% of children, without using any additional device. No intubation was impossible, regardless of the difficulties predicted by the Colorado Pediatric Airway Score and the videolaryngoscopic view obtained. All difficult tracheal intubations not predicted by parameters and scores were successfully performed (2,92% in our case series).

Conclusion

Routinary use of videolaryngoscopy has encouraged and optimised teamwork, including training; reduced the time spent in the operating room and the use of additional devices for managing difficult airways; completely decreased clinical risk of difficult intubations, eliminating the impossible ones; made it possible to overcome the limits of the Colorado Pediatric Airway Score, a score predicting difficult intubation in children, allowing us to manage easily any unexpected difficult airways; permitted the hypothesis of abandoning, for the near future, scores and parameters predicting difficult intubation, with huge benefits in terms of time spent on surgical patient preoperative evaluation.

Keywords

Routine videolaringoscopy; videolaringoscopy; pediatric airways risk management; clinical risk; pediatric tracheal intubation; pediatric airways management; anesthesia clinical risk management.

Introduction

Initially conceived as a response to the increasing number of medico-legal disputes and their economic impact, enriched over time with deontological values, health risk management represents today the set of multidisciplinary complex actions carried out to improve health care quality in order to ensure the maximum safety of the patient, a safety based on learning from mistakes, which, although ineliminable from human reality, can be controlled.

The perioperative clinical risk, i.e. the likelihood that a patient will suffer an adverse event, i.e. suffer any harm or discomfort, even if unintentionally produced, as a result of medical and surgical procedures performed during the perioperative period, is associated with a prolonged period of hospitalisation, worsening of health conditions or death, with increased economic and social costs. The basis of clinical risk is error, the probability of making a mistake. An active or executive error, i.e. committed by professionals in direct contact with the patient, often arises from a latent or planning error, which is remote in time and related to system design decisions. The system can therefore be wrong and can create the circumstances for an error to occur; these circumstances remain latent until the operator's error makes them manifest. Controlling these circumstances through the creation of ideal working conditions in fact represents the only way to make the whole process safe[1](Table 1 and Table 2).

Human error has always been considered primarily for its consequences on patient outcome without considering the impact it also has on the health of health workers themselves in terms of guilt, anxiety and depression. The pervasive culture of perfectionism, intolerance to mistakes and blaming the individual, typical of medical settings, together with the lack of staff and support from the management amplify these negative effects[2].Complications relating to airway management continue to be the subject of medical and legal disputes throughout the western world[3-6], and these disputes are due to both technical issues and team issues, the so-called "non-technical skills". Several American studies on adverse events in anaesthesia based on closed claims indicate that respiratory events are responsible for 17% of disputes, of which 27% are due to poor management or problems regarding airways. Three quarters of adverse respiratory events are due to three causes of injury: inadequate ventilation (38% of cases), esophageal intubation (18% of cases) and difficult tracheal intubation (17% of cases)[7,8] Cook TM et al. report an incidence of a major complication (death or post-anoxic coma) every 22.000 general anaesthesias[9].

30% of accidents resulting exclusively from anaesthesia are caused by difficulty in managing the airway; 70% of these accidents result in permanent brain damage or even death[10]. It can be estimated that every year in Italy there are at least 10-15 new cases of severe acquired brain injury, which means conditions leading to a more or less prolonged state of coma (usually lasting no less than 24 hours) and sensorimotor, cognitive or behavioural damage, resulting in significant disability. In terms of prevalence, it can be assumed that between 300 and 800 people per 100,000 have a severe acquired brain injury, with a predominantly traumatic aetiology (62.14% of cases). Regarding the vegetative state the prevalence is about 6-10 cases per 100,000 inhabitants, with an estimated incidence, six months after the event of acute brain injury, ranging from 0.5 to 4 per 100,000 inhabitants[11-13]. There is general consensus in literature that airway management mortality today is still mainly due to organisational failures, lack of communication and inadequate strategy, especially in terms of foresight[14,15].

It has been reported that the human factor can contribute between 40% to 100% in the failure of adequate airway management: part of the difficulty lies in the way the team acts during the planning and execution of an expected difficult intubation and, more importantly, in an unexpected one[16,17].

Training in the management of difficult airways can reduce the possibility of error, whether conducted in the field or in simulated scenarios. However, it should be noted that years of experience in the field differs from expertise, intended as a real training programme towards gradually more complicated scenarios, adapted to the skills and knowledge of the individual operator[20,21].

The international literature shows that difficult intubation in non-obstetrical-gynecological adult surgery has an incidence of 3-8%, with an incidence of impossible intubation of 0.006-0.4%. In gynaecological-obstetrical surgery the incidence of difficult intubation is 1.6-5.7% with impossible intubations less than 0.7%. In paediatric surgery the incidence of difficult intubation is 0.2-5.5%, with impossible intubations of 0.08%; instead, the prevalence of difficult OTI is 1-2%, a proportion which rises to 50% when considering the subpopulation of paediatric patients with cervical spine diseases[22-26]. Among obese patients the incidence of difficult intubation can be up to 15%[27].

The Canadian Airway Focus Group currently recommends videolaryngoscopy as the main technique to facilitate orotracheal intubation on first attempt and to reduce complications associated with the manoeuvre. A successful first attempt actually accelerates the whole oro-nasotracheal intubation manoeuvre, with obvious benefits also in economic terms due to the optimisation of operating room utilization time and the reduction in the need for additional difficult intubation devices. The study group also emphasises that the referral hospital, which provides the devices required to manage difficult airways, must also make them easily and immediately accessible if necessary[18,19].

The use of videolaryngoscope also promotes teamwork and the involvement of team members by visually sharing the findings during the intubation manoeuvre. A shared view can in fact optimise team communication by accelerating and facilitating steps and procedures, thus reducing risks and complications related to ineffective communication.

Potential human factor issues during patient evaluation and airway management decision-making, with suggested mitigation strategies

Issue	Possible mitigation strategies:		
	by the airway manager	by the assembled team	by the organization
Failure to match planned strategy with the findings of airway evaluation (anatomy, physiology, and clinical context)	• Review your planned strategy for a high-risk or difficult case with a colleague. • With predicted difficulty, before proceeding, ensure that all equipment for your airway strategy (i.e., planned primary and fallback techniques) is physically present, sized for the patient, and arranged in the order of anticipated use. This well help ensure you have thought through the situation.	• For all patients, brief the team on your chosen strategy, including your alternate plans if the intended technique fails, together with triggers for moving to an alternate plan. • During the briefing, specifically empower team members to speak up if they think that a trigger has occurred.	• The organization should mandate inclusion of the airway strategy in the first surgical safety checklist. • Airway management education programs should include material on safe decision-making, rather than only teaching "hands-on" skills.
Maintenance of competence. Use of ATI is decreasing[243]. When difficulty is predicted, lack of recent experience, confidence, or skills in ATI might tempt the airway manager to avoid its use despite indicators of it being the safest approach. Lack of suitable equipment might also be a factor in some cases.	• Enlist a colleague to help perform ATI: you will both benefit from the experience. • Seek opportunities to perform ATIs, rather than using excuses to avoid them. • If the patient's anatomy is amenable, consider using a more familiar device for ATI (e.g., VL).	• For the patient requiring ATI with obstructing pathology, a surgeon should be physically present to perform fallback eFONA.	• The organization should provide training and maintenance of competence workshops in ATI techniques, including use of the FB. • Provide airway simulators or standard airway training manikins for individual practice at any time. • Ensure equipment for all aspects of ATI is easily accessible at airway management locations. • Package all equipment and local anesthetics needed for topical airway anesthesia together in easily-accessed "grab kits".
"*Production pressure*" to get a case done might lead to an unsafe decision to manage a difficult airway patient after the induction of general anesthesia, when ATI might be the safer approach.	• When sensing production pressure, (whether self-induced or from another source) push back by deliberately slowing to reflect on whether the pressure is adversely impacting your patient's safety. • Pre-empt any pushback on planned ATI by using "safest for the patient" language.	• Increase team buy-in by early communication with the surgeon and team when ATI is needed for an operative case.	• Multidisciplinary team training or rounds on adverse airway events might help improve communication and cooperation for future difficult airway situations that involve multiple specialties.
"*Normalization of deviance*[3]": the airway manager might have managed a series of patients after the induction of general anesthesia where despite predictors of difficulty, none occurred. On the basis of thus "getting away with it" over time, inducing such patients might become a clinician's normal practice, rather than even considering ATI.	• With significant predicted difficulty, if considering tracheal intubation after the induction of general anesthesia, as a thought exercise, satisfy yourself that it can occur with a margin of safety equal to or greater than ATI. If not, proceed with the ATI. • Beware of "gambler's fallacy": the false belief that the outcome of the current case is less (or more) likely given results of previous events. Judge every case on its own, based on findings from the airway evaluation.	• Team members should be encouraged to speak up if uncomfortable with the airway manager's chosen approach. The "PACE" (probe-alert-challenge-emergency) or similar mnemonic can be used as a prompt by team members to question the planned approach.	• Appoint a hospital "airway lead"[244] in your department or hospital, tasked with ensuring a full array of difficult airway equipment is readily available across the institution, arranging airway education, including skills in ATI, and to help constructively debrief airway-related critical incidents and near-events.

ATI = awake tracheal intubation; eFONA = emergency front of neck airway access; FB = flexible bronchoscope; VL = video laryngoscopy.

Table 1: Potential human factor issues during patient evaluation and airway management decision-making, with suggested mitigation strategies. From Law, J.A., Duggan, L.V., Asselin, M. et al.[18].

Potential human factor-related issues that may occur during management of the difficult airway in the unconscious patient, with mitigation strategies

Issue	Possible mitigation strategies:		
	by the airway manager	by the assembled team	by the organization
Calling for help: The airway manager might overlook calling for help when difficulty occurs.	• Have personal triggers for calling for help, e.g., (1) whenever you *first* contemplate it; (2) failed intubation or failed SGA insertion after a maximum of 3 attempts or (3) a CVCO situation. • Recognize that a helper can provide hands for tasks, so that the airway manager can concentrate on the "big picture" and reduce their stress level. • Consider making a habit of asking a colleague to physically stand by when inducing a patient with *anticipated* airway risk.	• Strongly consider physically attending any request for backup, even if phrased as a "heads-up". • A helper should announce their arrival by asking "How can I help?" • Any team member should be empowered to call for help, bring in equipment, or call a code blue independently.	• All departments should foster a culture of calling for help. • During team training, e.g., during *in situ* simulation sessions, requesting help should always be debriefed as a critical action.
Loss of "situation awareness." During an airway crisis, it can be difficult to correctly receive and process incoming information. This will impair diagnosis and decision-making and may promote inappropriate fixation on a single familiar but ineffective technique (perseveration).[285]	• Maintaining situation awareness involves long-term memory content, which may be difficult to access during a critical event. Help from other staff provides the airway manager with additional processing capacity for integration of basic information.[285,286] • Call for help after 3 failed attempts at the intended technique: a fresh pair of eyes will help interrupt perseveration. Be alert for the "change blindness"[200,201] that can occur when a critical airway event evolves over time. A newly arrived helper may better be able to see the obvious. • Use difficult airway techniques in day-to-day routine practice (e.g., the combination of VL and FB) so that their use is practiced, and so that you think of them when in difficulty.	• Perform a team briefing before embarking on all airway management. Include specific mention of triggers for moving from one plan to the next and empower all team members to speak up once they feel a trigger has occurred. • Team members should be trained in the interpretation of waveform capnography and pulse oximetry and should be empowered to declare when waveform capnography is non-reassuring or the SpO_2 is decreasing. • Ensure all team members have been empowered to suggest using an SGA for rescue or CVCO at any time and that they know the equipment's location.	• Mandate adherence to a standard operating procedure for the difficult airway by using an algorithm or cognitive aid based on the algorithm. • Facilitate multidisciplinary *in situ* team simulation to practice using the algorithm or cognitive aid for difficult airway scenarios. A major objective during such sessions is to encourage and empower all team members to speak up. • Airway workshops should include education on non-technical as well as technical skills. Common cognitive errors should be addressed.
Fear. Faced with a hypoxemic patient, the airway manager might experience a maladaptive sympathetic response. This might include fight (e.g., arguing with team members); flight (e.g., disbelief of patient vital signs) or freeze (e.g., not performing eFONA when indicated).	• Call for help early in any evolving airway event. Not being emotionally invested, a newly arrived colleague might possess better situation awareness. • Have a strategy (a coordinated series of plans) for encountering difficulty in *all* patients, whether predicted or not. Moving smoothly and deliberately through the steps of a pre-planned strategy will help keep you in control of yourself as well as the situation. Mentally rehearse the strategy on a regular basis.	• During an airway crisis, team members must recognize that the airway manager who induced the patient is deeply emotionally invested. They might be experiencing a profound sympathetic response, compromising thinking or motor skills. Any team member should call for help if they feel it is in the best interest of the patient. • Once qualified help arrives, the initial airway manager should consider moving to a supportive role on the team, providing information and suggestions.	• High acuity but rare events such as CVCO should be "overlearned" during simulation sessions.[286] This will help demystify them and make their management more routine in clinicians' minds.
Barriers to use of eFONA can include not knowing which procedure to employ ("device confusion"), lack of confidence in one's ability to perform the procedure, or a "freeze" response to fear. The reluctance to act may manifest by insisting a surgeon or better qualified person be called to perform eFONA.	• By training in eFONA, all airway managers must be prepared to proceed with eFONA themselves. • Deliberately practice eFONA on a part-task trainer at least twice a year. • When encountering difficulty, follow the department's recommended algorithm or cognitive aid.	• Team performance in rare emergencies such as CVCO benefits from *in situ* simulation. • Swapping team roles during simulation sessions may reveal latent errors in communication and equipment.	• The organization should ensure that all airway managers are trained in and prepared to perform eFONA. • Minimize choices to a single technique for high-stress procedures such as eFONA (e.g., scalpel-bougie-tube for the adult patient). • Make task trainers easily accessible for individual clinician eFONA practice. This can include 3D-printed models of the larynx.

Table 2: Potential human-factor related issues that may occur during management of the difficult airway in the unconscious patient, with mitigation strategies. From Law, J.A., Duggan, L.V., Asselin, M. et al.[19].

Objectives

The main objective of this study is to evaluate the routine use of videolaryngoscopy as a clinical risk and unexpected difficulties mitigator during oro- and nasotracheal intubation of pediatric patients undergoing scheduled or emergency surgery. The secondary objective is comparing the Colorado Pediatric Airway Score, a score predicting difficult intubation in children, with the findings during oro-nasotracheal intubation under videolaryngoscopic vision according to the Fremantle classification.

Material and Methods

For the purpose of this prospective, non-interventional, non-pharmacological, descriptive observational study, 137 pedriatric patients (aged from 3 to 16 years of age) were recruited at the E. Profili Hospital in Fabriano - UOC Anesthesia, Intensive Care, Pain Therapy. Such patients underwent in a scheduled or emergency regimen in the specialties of general surgery, urology, ophthalmology, odontostomatology, otorhinolaryngol ogy, orthopaedics. Preoperative data such as surgical specialty, type of surgery, gender, age, weight, height, BMI, neck circumference measured in cm and Colorado Pediatric Airway Score (COPUR) (Table 3) were collected for each patient recruited. During the intubation manoeuvre through videolaryngoscope, visual findings were assessed using the Fremantle classification (Table 4). All data were collected using a computerised data sheet.

Colorado Pediatric Airway Score (COPUR)		Points
C: chin		
From the side view, is the chin		
Normal size?		1
Small, moderately hypoplastic?		2
Markedly recessive?		3
Extremely hypoplastic?		4
O: opening		
Interdental distance between the front teeth		
>40 mm		1
20–40 mm		2
10–20 mm		3
<10 mm		4
P: previous intubations, OSA (obstructive sleep apnoea)		
Previous intubations without difficulty		1
No past intubations, no evidence of OSA		2
Previous difficult intubations, or symptoms of OSA		3
Difficult intubation—extreme or unsuccessful; emergency tracheotomy; unable to sleep supine		4
U: uvula		
Mouth open, tongue out, observe palate		
Tip of uvula visible		1
Uvula partially visible		2
Uvula concealed, soft palate visible		3
Soft palate not visible at all		4
R: range		
Observe line from ear to orbit, estimate range of movement, looking up and down		
>120°		1
60–120°		2
30–60°		3
<30°		4
Modifiers: add point for		
Prominent front 'buck' teeth		1
Very large tongue, macroglossia		1
Extreme obesity		1
Mucopolysaccharidoses		2
Predictions Points	**Intubation difficulty**	**Glottic view**
5–7	Easy, normal intubations	1
8–10	More difficult, laryngeal pressure may help	2
12	Difficult intubation, fibreoptic less traumatic	3
14	Difficult intubation, requires fibreoptic or other advanced methods	3
16	Dangerous airway, consider awake intubation, advanced methods, potential tracheotomy (Patients with hypercarbia awake, severe obstruction)	4
16+	Scores >16 are usually incompatible with life without an artificial airway	

Table 3: "Colorado Pediatric Airway Score (COPUR)" from Lane G.[28]

FREMANTLE SCORE COMPONENTS			
View	**F** (full)		
	P (partial)		
	N (none)		
Ease	**1** - Easy	TT passed first time using manufactures technique	
	2 - Modified	TT passed with more than 1 attempt or a modified technique or adjunct used	
	3 - Unachivable	Unable to pass TT	
Device	Name of the device and blade used		

Table 4: "Fremantle videolaryngoscopy classification" from Swann AD et al.[29] and O'Loughlin et al.[30]

Results and Discussion

Videolaryngoscopy has become the routine practice in the operating block of Profili Hospital in Fabriano since November 2021, in the context of elective and emergency surgery pediatric patients. Each operating room was therefore equipped with a videolaryngoscope and a complete set of blades, including a special blade for difficult intubations. Our case history shows that 95,62% of pediatric patients underwent oro-nasotracheal intubation at the first attempt, with no need, in any case, for additional devices and with the margin of human error reduced to a minimum. The clear benefit of less time spent on the manoeuvre has led to an optimisation of the operating lists in our operating block, as well as a reduction in costs derived from a more efficient use of the operating room and no need for additional devices for difficult intubations. A more rapid manoeuvre represented an important benefit for the patient in terms of clinical risk, unexpected events and possible complications. The routine use of videolaryngoscopy for pediatric patients has allowed us to eliminate impossible intubations regardless of laryngoscopic view and its consequences, both clinical (e.g. admission in UTI), organizational (e.g. postponement of surgery) and psychological (e.g. work-related stress for operators). A Colorado Pediatric Airway Score of more than 7 was found in 8,03% of cases, indicating a possible problematic intubation; in these patients, however, we obtained a complete videolaryngoscopic view in 100% of cases and 80% of the patients were intubated at the first attempt despite not using in any case the special blade for difficult intubations. A Colorado Pediatric Airway Score of 7 or less, predictive of a non-problematic intubation, was found in 91,97% of pediatric patients; in these patients, however, we found a partial videolaryngoscopic view in 2,92% of cases. 4,37% of cases required a second intubation attempt. A standard blade was used in 99,27% of cases. The benefit of the routine use of videolaryngoscopy therefore largely exceeds that of the predictive scores of difficult intubation in children, since it has guaranteed successful intubation in 100% of cases regardless of the predicted difficulty. From the perspective of risk management, a routine use of videolaryngoscopy has allowed us to successfully perform all difficult tracheal intubations not predicted by the Colorado Pediatric Airway Score, which amount, in our case series, to 2,92%. Such findings are aligned to results obtained in our previous preliminary study. It is therefore natural to wonder about the opportunity, in the near future, to replace predicting scores with the routine use of a highly effective device such as the video- laryngoscope. Videolaryngoscopy has also been of great benefit to the teamwork of Profili Hospital in Fabriano, facilitating collaboration and interaction among the operators and accelerating and optimising the entire tracheal intubation procedure. The shared view of the glottic plane favoured by this device was useful both for correcting operator-dependent errors and for training resident doctors (all results are showed in Table 5).

VARIABLE	EVALUATION	N° (%)
Gender	Male	77
	Female	60
Age (years)	3-6	82
	7-12	35
	13-16	20
BMI	< 30	135
	≥ 30	2
Neck circumference	< 30	76
	≥ 30	61
Chin characteristics	Normal size	130
	Small, moderately hypoplastic	6
	Markedly recessive	1
	Extremely hypoplastic	0
Interdental distance between the front teeth (cm)	< 1	0
	1-2	0
	2-4	11
	> 4	126
History of OTI and OSAS	Previous OTI not difficult	16
	Never OTI, no OSAS	103
	OTI difficult or OSAS	18
	Failed OTI, emergency tracheostomy or sleeping prone	0
Uvula	Tip visible	122
	Partially visible	14
	Not visible, only soft palate	1
	Soft palate not visible at all	0
Head flexion-extension (degrees)	> 120	135
	60-120	1
	30-60	1
	< 30	0
Modifiers	Prominent front “buck” teeth	10
	Macroglossia	4
	Extreme obesity	2
	Mucopolysaccharidosis	0
Colorado Pediatric Airway Score (COPUR)	5-7	126
	8-10	10
	11-12	1
	14	0
	16	0
	> 16	0
View of the vocal cords with videolaringoscopy	Total	133
	Partial	4
	None	0

Table 5: Paediatric patients results.

Conclusion

Airway management is one of the key issues in current anaesthesiological practice, in which human error plays an important role.

The routine use of videolaryngoscopy in the operating block of Profili Hospital in Fabriano has made it possible:

- To encourage and optimise training and teamwork;
- To optimise economic resources, obtaining a reduction in time spent in the operating room and a reduction in the use of additional devices for managing difficult airways;
- To completely eliminate the clinical risk of difficult intubation, achieving correct tracheal intubation in 100% of cases, eliminating impossible intubations and their clinical and organisational consequences, particularly in paediatric patients, who are a particularly high-risk category in airway management;
- To overcome the limits of the Colorado Pediatric Airway Score (COPUR), a score predicting difficult intubation in children, making it easy to manage unpredicted difficult airways.
- To hypothesize, for the near future the abandonment of predictive scores of difficult intubation, with enormous benefits on the time spent in the preoperative evaluation of the surgical patient.

Disclosures

Ethical Committee approval

Ethical approval was obtained from the regional ethical committee (Comitato Etico Regionale delle Marche - CERM), protocol no: 2022 82 (09-06-2022, Det. n. 1148/AV2 23/06/2022).

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Conflict of interest

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