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Teaching Anaesthesia Residents Advanced Airway Skills: A Proposal for Teaching Orotracheal Intubation Using a Fiberoptic Bronchoscope

Ensino da Via Aérea Avançada a Internos de Especialidade: Uma Proposta para o Ensino de Intubação Orotraqueal com o Uso de um Fibroscopio Flexível

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ABSTRACT

The correct teaching of technical skills is fundamental to ensure patient safety. According to the Practice Guidelines for Management of Difficult Airway from the ASA, an awake intubation with a flexible bronchoscope should be attempted first, whenever a difficult airway is anticipated. Therefore, trainees should be autonomous in the successful use of a fiberoptic bronchoscope when faced with difficult airway management. This paper describes an educational proposal for teaching fibreoptic intubation to trainees. Such a strategy can be used in hospitals that do resident training. A few conceptual frameworks behind this strategy will be discussed first, followed by an instructional checklist to guide the trainee in the procedure, without risking patient safety.

RESUMO

O ensino correto de uma técnica é fundamental para garantir a segurança do doente. De acordo com as *Practice Guidelines* for *Management of Difficult Airway* da Sociedade Norte Americana de Anestesiologia (American Society of Anesthesiology), deve optar-se por uma intubação vígil com o uso de fibroscopia flexível sempre que se antecipe uma via aérea difícil. Por este motivo, os Internos de Especialidade devem ganhar autonomia no manuseamento correto de um fibroscópio flexível, para que possam abordar uma Via Aérea Difícil de forma segura. Este artigo descreve uma proposta educacional para o ensino avançado da intubação com o uso de fibroscopia flexível a internos de Anestesiologia. A estratégia descrita pode ser usada em vários tipos de hospitais (Centrais/Distritais) com idoneidade formativa. Primeiro, discutir-se-ão algumas teorias educacionais que serviram de base a esta proposta. Seguidamente, será descrito um processo educacional para facilitar os tutores no ensino desta técnica avançada de manuseamento da via aérea, sem comprometer a segurança do doente.

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INTRODUCTION

Anaesthetists are considered experts in difficult airway management. It is however recognized that many trainees have insufficient exposure to difficult airways during their clinical training.[1] According to the Practice Guidelines for Management of Difficult Airway from the ASA,[2] an awake intubation with a flexible bronchoscope should be attempted first, whenever a difficult airway is anticipated. Therefore, trainees should be autonomous in the successful use of a fiberoptic bronchoscope (FOB) when faced with difficult airway management. In this paper, a strategy for teaching fibreoptic intubation to trainees will be discussed.

LEARNING OUTCOMES

After the end of such a teaching event trainees are expected to:

1. Choose the adequate FOB intubation mode according to the situation;
2. Correctly prepare all the equipment and medications necessary;
3. Correctly prepare the patient and position the airway;
4. Identify normal pharyngeal and laryngeal anatomy;

5. Show competence in the mechanical manipulation of the FOB:
a) Introduce the bronchoscope according to successive directions (first downwards, then anteriorly at the level of the vocal chords and finally downwards again);
b) Keep the bronchoscope in the sagittal median plane;
c) Remove the bronchoscope under visual control;
6. Assess correct placement of the endotracheal tube (ETT) in the patient´s trachea;
7. Name the basic caveats of the technique and be able to troubleshoot through them.

Because teaching may be accomplished in several ways, we would like to account some educational conceptual frameworks that we used for our proposal:

THE "APPRENTICE" MODEL:

This traditional model of apprenticeship originated in Middle-aged Europe for the training of craftsmen. It has been extensively used within vocational pedagogy: it refers to an asymmetrical relationship between someone who has mastered the skills of the trade (the master), and another who has not (the apprentice). This model relates to constructivism and Bandura´s social learning paradigm[3] and it is widely used in anaesthesia "bedside" teaching, with a close supervision by a teacher. Although the apprenticeship model has stood the test of time, it is not devoid of problems: for once, patients have become independent individuals actively involved in their medical management with basic, sometimes distorted, medical knowledge gained through different forms of information and are increasingly aware that "apprentices" use them for practice; on the other hand, the medico-legal system prompts patients to exercise their right to demand results and to file complaints when they suffer a complication. This has created greater awareness of the lack of training in technical and clinical skills and has increased the fear of practicing on real patients with the possibility of making mistakes; finally, from the teacher´s point of view, there are low risk situations where the teacher is in control, but if a patient requires an emergency treatment, the safety net of the trainee´s "correctable" gestures may disappear.

MASTERY LEARNING WITH DELIBERATE PRACTICE:

Mastery learning (ML) requires that competence in a certain instructional level is achieved before stepping up to the next level.[4-6]

ML is therefore relevant to competency-based education and training in anaesthesia, as it emphasizes defined objectives rather than number of procedures. It elaborates on the basics of a procedure and defines the goals to be achieved. There are various known ways of achieving ML. What seems to influence practice is 1) "the way in which the task is practiced", i.e. as a whole procedure or only learning parts of it and in a stepwise order or randomly [known as contextual interference[7-9]] and 2) "the way in which practice sessions are distributed", either "in chunks" or in random teaching sessions, also known as "distributed practice".[10-12]

ML implies the concept of deliberate practice, i.e. repeated carrying out of skills in a specific area, coupled with assertive, goal-oriented assessment that also grants trainees a specific, informative feedback, allowing for repetitive practice opportunities to enable sustained improvement, with the goal of achieving mastery and competency.[5,13] A classic example of mastery learning with deliberate practice is simulation. Its use is described below.

A) COGNITIVE LOAD THEORY (CLT)

The central idea of CLT is that cognitive architecture, that consists of a severely limited working memory, interacting with a theoretically unlimited long-term memory, is key in learning.[14] The theory considers an intrinsic load (related to performing a task), the extraneous load (not essential to the task) and the germane load (processes from the task that directly contribute to leaning, like schema construction or schema automation).[15] According to CLT, if we expect learning to happen, these three types of information processing cannot go over the available working memory capacity. Therefore, well-designed instructional messages should increase germane cognitive load while decreasing extraneous cognitive load. This learning process is achieved by using the available working memory (without "overflow"). Conversely, if enough strain is placed on the working memory, then the mind´s ability to develop mental models (i.e., expertise) is harmed. Simulation has been shown to "decrease unnecessary extraneous load while optimizing the more necessary and appropriate intrinsic and germane load that help make learning effective".[16]

The combining of concepts of these three educational conceptual frameworks led to the proposal of a specific stepwise teaching method.

SET-UP AND PROCEDURE DESCRIPTION:

During anaesthesia "bedside" teaching, the aim should be to protect patient safety while allowing the trainee to attain proficiency on procedure performance. In order to safeguard this, we propose a teaching strategy that incorporates alternative ways for teaching procedural skills outside the workplace. We introduced a visit to the simulation lab, therefore exploring the principle of ML. Trainees are encouraged to get familiar with the in-house fibreoptic device before they try it on a patient. This may take one to several sessions, depending on the dexterity of each trainee. An assessment tool, such as the CuSum score[17] may be used

to assess proficiency (more details in Appendix 1).

As soon as the trainee has shown a stable performance on the simulation lab, he may be allowed to proceed to the next level of training, at the bedside. A proposed description of the patient encounter is described below. The trainee is expected to prepare the equipment and all steps described below independently, to achieve competency.

DESCRIPTION OF THE TECHNIQUE[18]:

A) Pre-operative assessment and briefing of the trainee:

1. Ask the trainee about his/her previous experience and discuss with him/her the plan for the patient, assessing feasibility of the technique. This includes choosing the appropriate fiberoptic intubation mode (nasal/oral) with the patient anesthetized or awake. We suggest the following stepwise increase in difficulty:

a) **Anesthetized oral:** Offer the possibility for practice of fiberoptic intubations to ASA I and II patients who are proposed for an oral intubation – this provides more learning opportunities and can be less traumatic pharyngeal soft tissues and teeth. It also causes less fluctuations in patient haemodinamics than direct laryngoscopy. Please consider that fiberoptic intubation takes a few seconds longer and it could be accompanied with decreases in pulse oximetry. The trainee should also be able to critically assess the feasibility of the technique and ask for informed consent.

b) **Anesthetized nasal:** in patients having operations in the oral cavity or with a previous history of difficult airway found on direct laryngoscopy.

c) **Awake nasal:** in patients undergoing an operation on the oropharynx or mouth and all those proposed to nasal intubation.

d) **Awake oral:** in patients with difficult airway predictors (Mallampati grade III and IV patients).

2. Expect the trainee to show professionalism and give a thorough description of the technique to the patient, including what to expect, complications and risks. Bear in mind that patient refusal is a contraindication to FOB Intubation. Additionally, the use of FOB for intubation should not be primarily used in patients in whom a rapid sequence induction (RSI) is needed.

3. In addition to a thorough informed consent, the trainee is expected to collect an anaesthetic history, physical examination and specific questions about previous airway trauma or surgery and a history of epistaxis or bleeding. Previous records should also be consulted and sought for details of previous unsuccessful or difficult intubation attempts.

B) Operating room preparation:

The trainee should be able to prepare the setting accordingly and independently. Your job as teacher is to act as facilitator. The difficult airway task force[2] emphasized that "preparatory efforts enhance success and minimize risk to the patient".

1. There should be at least one qualified assistant (ourselves or a third element) to help manage the airway. The trainee is expected to understand that he cannot perform a fibreoptic endotracheal intubation alone and should delegate to the assistant the following functions during the procedure:
- To observe the patient clinically;
- To use standard monitoring during the endoscopy;
- To administer intravenous sedatives/co-adjuvants;
- To inject lidocain 1% through the work channel of the fiberscope under his/her direction.

2. The trainee should make sure that the procedure takes place in a calm and quiet setting with good lighting. Adjustment of the height and tilt of the bed should be used. A foot stool to stand on should be available to allow him/her to hold the insertion cord of the fiberscope.

3. Finally, the trainee should ensure that all equipment is checked and ready for use (this includes equipment, medication, resuscitation and monitoring). The fibreoptic equipment should be positioned so that it can hold up easily. Care should be taken to avoid draping the camera cable or the light source cable across the patient's face. The fiberscope should be stored in a vertical plastic holder to avoid coiling. Basic intra-operative monitoring should include a heart rate monitor, non-invasive blood pressure monitoring and pulse oximetry. Standard difficult airway equipment should to be available and organized carefully on a separate mobile trolley. This trolley should include the following:
- Range of laryngoscopes.
- Range of endotracheal tubes.
- Gum elastic bougies, Magill's forceps.
- Laryngeal mask airway.
- Cricothyroidotomy set and connections for jet ventilation.

This trolley should be readily accessible and be checked by the trainee.

C) Equipment preparation:

The necessary equipment includes a range of oral/ nasal armored/regular tubes, a lubricant, a defogging agent, lidocaine in its various forms, oral intubation airways, soft nasopharyngeal airways, suction, needles, syringes, cotton-tipped applicators, nebulizer and an appropriate sized laryngeal mask airway. The chosen endotracheal tube is loaded over the lubricated fiberscope, having removed the 22 mm connector. The distal 20 cm of the insertion tube should be kept free of lubricant so that the endoscopist´s gloved hand can grip and manipulate this portion. The connector should be placed in a secure place for convenient reconnection.

PROCEDURES FOR USING THE FOB CART:

1. Plug in the master power;
2. Turn on the light source, camera and monitor;
3. Fibreoptic bronchoscope:

a) Connect insertion cord to light source;
b) Adjust the light source intensity to an adequate level of illumination;
c) The insertion tube should be inspected for dents and bulges and the angulation lever manipulated to ensure that the distal tip responds appropriately;
d) Connect oxygen 3-4 L/min to working channel. Orient the working channel to lie under the left index finger while the left thumb controls the angulation lever, thus leaving the right hand free to manipulate the insertion tube;
e) Connect a 10 cc non-luerlock® syringe of 1% lidocaine onto the biopsy valve diaphragm for a "spray as you go" technique;
f) Ensure a new biopsy valve is snapped onto the biopsy port before each use;
g) Defog the tip. Dip the tip in defogger liquid once or twice before using it on the patient;
h) Place the endotracheal tube over the fiberscope and lightly secure it with tape to the upper end of the insertion cord.

4. Camera and monitor: A coupler is used to connect the camera to the fiberscope. Adjust the pivot to 12 o'clock. Focus the camera by twisting the dioptre ring just above the camera and check for the "white balance". The use of the TV monitor is compulsory. This guarantees that both you and the trainee have access to a real-time image of the airway.

5. Suction: check for central wall suction is not available. Both a soft-tipped flexible suction catheter or a stiff Yankauer suction tip can be used.

6. Oxygenation: The safety of the procedure is enhanced by the use of supplemental oxygen. Nasal cannulae can be used at 2-3 L/min if the oral route is chosen. When performing a nasal intubation, a modified facemask with a hole for the FOB should be readily available. In certain circumstances, the use of the THRIVE system (transnasal humidified rapid-insufflation ventilatory exchange) could be indicated and should be prepared accordingly and its use explained to the patient.

7. Pharmacological adjuvants: The trainee may choose to use antisialogogues and sedation. This should be previously discussed with the teacher and both need to agree to its use. Our most commonly used antisialogogue is glycopyrrolate, but atropine and scopolamine can also be used. In the case of sedatives, make sure that the trainee is aware that patients with significant airway compromise, airway patency is maintained through muscle tone and sedatives should be avoided.

8. Local anaesthesia: For the purpose of anesthetizing the upper airway, the trainee needs to have a plan for the several anatomical sites of the airway: nasal cavity and nasopharynx, oral cavity and oropharynx and larynx. The nasal and oral mucosa can be anesthetized with spray delivery of 10% lidocaine (xylocain®). Additionally, three long cotton-tipped pledgets soaked in lidocaine/phenylephrine mixture can be painted methodically along the nasal mucosa and then left for around 10 minutes. The larynx can be anaesthetised with the "spray as you go technique". Other options are possible (blocks, transtracheal injection) if both parties agree.

D) Performing the procedure:

Ask the trainee to describe the technique as he/she performs it. This should include (but not be limited to) the following steps:

1. The trainee makes sure that the airway is open from the mouth to the glottic opening, either by using an oropharyngeal device, asking for patient collaboration or instructing the assistant to perform a jaw thrust.

2. The trainee makes sure that the fiberoptic shaft remains lined up, (usually) by standing on a lift and holding the FOB straight above the patient. Traditionally, the endoscopist holds the handle with the dominant hand, in order to control the FOB lever more precisely. With the non-dominant hand, the trainee should hold the bronchoscope shaft a few cm from the shaft tip and position it above the mouth/nose and insert it 90° to the horizontal plane. (In an oral approach, he/she should insert the shaft exactly in the midline of the mouth and oropharynx without tilting or bending or rotating it. In a nasal approach, he/she should insert the FOB tip through a nostril, keeping the tip slightly flexed so that it follows the normal anatomical curvature of the upper airway, until the posterior nasal pharynx is observed on the monitor.)

3. From this point onward, he should coordinate the fiberscope by use of the image on the monitor. From this point onwards, the basic movements should include advancing the scope tip through the glottis, straighten the shaft and face the trachea directly. If pink mucosa is all that can be seen on the monitor, you can hint him that he should flex the tip and follow the natural curvature of the airway.

a) He/she should slowly progress the tip further so both of you clearly identify the epiglottis and then the glottis;
b) He/she should advance the scope tip under the epiglottis until the cords can be observed. If the tip is off to one side, have him rotate both shaft and handle so to "center" the glottic opening.

4. Perform "spray as you go": This technique uses the working channel of the bronchoscope to spray the supraglottic structures and vocal cords with local anaesthesia. Under direct vision, the vocal chords are sprayed with local anaesthetic. The trainee should wait 30 seconds before further advancing the fiberscope.

5. The tip should be advanced until we can see the carina.

6. At this point, the trainee should ask the assistant to loosen the endotracheal tube connector from the bronchoscope handle, rotate the ETT 90° counter clockwise (to prevent the tip from being stopped by the arytenoids) and railroad it over the bronchoscope shaft until the 22-23 cm tube mark is at teeth level. He/she should also make sure that the patient is now deeply sedated and that this procedure is as comfortable as possible.
7. Finally, the trainee should withdraw the scope, confirm tube placement and secure the tube in place.
8. Once the position is confirmed, they can administer an intravenous (IV) hypnotic.

DISCUSSION

Simulation-based learning is designed to diminish contextual interference and it helps develop knowledge, skills and behaviours, while enhancing patient safety.

In the simulation lab, learners can rehearse the key physical gestures of the procedure as many times as they want without putting patients at risk, creating an optimal learning environment. The use of simulation conveys an essential educational and ethical message: patients are to be protected at all times and must not be used as objects to facilitate medical training. With the incorporation of simulation-based training, "the length of the learning curve for the achievement of proficiency on real cases may be reduced and better long-term retention achieved".[6,19]

The teacher´s presence serves to oversee skill acquisition and give copious concurrent feedback.[20] Some disadvantages of simulation include lack of realism in low-fidelity environments, limited access to high-fidelity simulation due to costs, time constraints and equipment "wear and tear".

So this is why we propose some sessions in the simulation centre (in an environment with lower contextual interference), before trying this technique in real patients.

Our department has a simulation centre that ensures optimization of anaesthesia techniques, be it in learning or maintenance of skills.

We have both standard intubation heads and an AFOI (awake fiber optic intubation) "box" - a computerised simulation that can be programmed with differing grades of intubation - epiglottis, tumours etc. Simpler fibreoptic training material can be easily obtained or self-built.When moving to the clinical environment of the induction room, trainees should start by performing fibreoptic intubations in low risk patients (no reflux, easy bag-mask ventilation) to allow them to get better at 'driving' the scope in a real airway, under direct supervision of a senior consultant, moving then to more difficult airways, also under supervision.

Because patients with difficult airways appear more frequently in the ORL department, we would expect trainees to be scheduled in this OR in a rotation, so that they could be exposed to these patients and still guarantee distributed practice.

CONCLUSION

The correct teaching of technical skills is fundamental to ensure patient safety.

We probably need to thrive for continuous, intensive and realistic training over a long period of time to reach a maintained cumulative effect.

We do not yet know if such techniques improve patient care, but changes both in organizational practice and patient´s benefit is what we aim for.

APPENDAGE

APPENDIX 1: CUSUM CHART

Each performance of the skill should be subject to formative feedback, reflection and assessment.

A CUSUM chart may be used to assess the individual trainee´s progress. An adequate performance for skill acquisition would be depicted by a CUSUM chart with a descending slope line.

The CUSUM curve depicts a graph of the consecutive attempts at performing a given technique, be it successful or unsuccessful attempts. We first need to devise a value that should be attributed to a successful and a failed attempt and it should reflect the "acceptable failure rate" for the technique being assessed.

A CUSUM score that demonstrates an acceptable performance would be similar to the graph above, showing a line with a downward slope. Drawing this graph over time also permits the insertion of limits (depicted in horizontal lines, see Fig. 1), that, if crossed, may hint the need for intervention. In this example, every successful orotracheal intubation will lead to the plot sloping down, but in the case of a failed procedure, the plot changes its slope up. Once the plot trends to move down in a constant fashion, proficiency has been achieved.

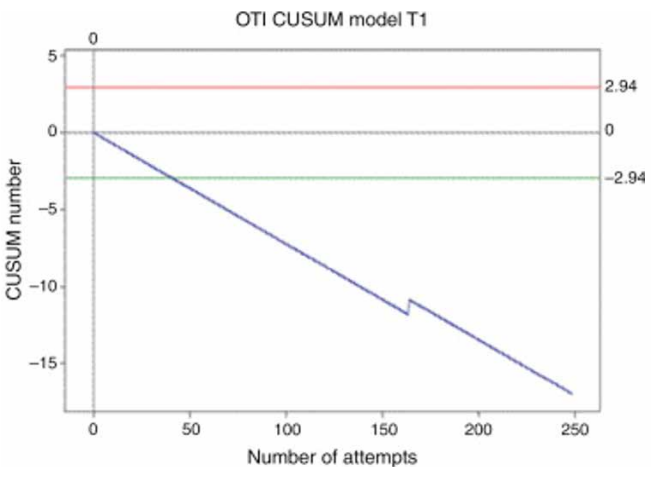

Figure 1. Shows a CUSUM Curve used by Ospina[17]

APPENDIX 2: MATERIAL CHECKLIST

Table 1. Material Checklist

MATERIAL CHECKLIST
Monitor: check if it is on and in running conditions
Light Source: Check if it is adequate, connect it to the FO and perform a "white balance"
DCI Camera Head: connect the camera head to the fibreoptic and perform an alignment and focus of the image
Flexible fibreoptic Bronchoscope with respective tote: perform "leak test"
Suction valves: check if they are present, connect one to the FO work canal and test for adequate suction
Silicone spray
Defogger and sponge
Alcohol preps
Nebulizer set
Nasal decongestant
Xilocain Spray
Lidocain 1% vials
Ovassapian airways
O_2 Supply tube

Responsabilidades Éticas
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