Perioperative Care and Operating Room Management xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Perioperative Care and Operating Room Management

journal homepage: www.elsevier.com/locate/pcorm

Clinical assessment for the identification of the potentially difficult airway☆

Cheng Zhou, Frances Chung, David T. Wong*

Department of Anesthesiology, Toronto Western Hospital, University Health Network, University of Toronto, Toronto, ON, Canada

ARTICLE INFO

Keywords:
Airway management
Difficult airway
Predictors of difficult airway
Identification of difficult airway
Patient safety

ABSTRACT

A core component of perioperative safety is airway management because patients are at risk for apnea, upper airway obstruction, and hypoxemia while under anesthesia. Every patient should be assessed preoperatively for potentially difficult airways in order to facilitate planning and preparation. Airway assessment includes a focused history and airway examination; imaging and endoscopy may be necessary in patient suspected to have challenging airways. Airway management can be divided into four aspects: bag mask ventilation, tracheal intubation, insertion of supraglottic airway and surgical airway. This narrative review summarizes bedside airway examinations and predictors of difficult airway in each of these aspects. However, in spite of these predictors, situations of an unanticipated difficult airway can still occur.

1. Introduction

Forty million anesthetics are delivered in North America every year. Anesthesiologists play an integral role in keeping patients safe in the perioperative setting.[1] An important part of anesthetic management is establishing and maintaining a patent airway. This is vital because patients are at risk for apnea, hypoxemia and upper airway obstruction while under anesthesia or sedation. Therefore, airway evaluation is an important part of every pre-operative assessment.

The primary goal of the airway examination is to identify potentially difficult airways. The American Society of Anesthesiologists (ASA) defines a difficult airway as "the clinical situation in which a conventionally trained anesthesiologist experiences difficulty with facemask ventilation of the upper airway, difficulty with tracheal intubation, or both."[2] When a potentially difficult airway is identified, the anesthesiologist needs to formulate alternative methods for securing the airway which can involve additional personnel, time, equipment and preparation.

In an ideal world, we would be able to identify every difficult airway, but in reality we run into unanticipated difficult airways. Norskov et al. showed in a cohort study of 188,064 patients that 93% of difficult intubations were unanticipated. When a difficult intubation was predicted, only 25% had an actual difficult intubation.[3] Having more knowledge of the different predictors of difficult airway will help us better anticipate and prepare for these challenging situations.

When unanticipated airways are encountered, most are secured by the use of adjuncts (i.e. videolaryngoscopy, tracheal tube introducer, supraglottic airway) and rarely is there a need to progress to a surgical airway.[4] In spite of the new airway adjuncts, cannot intubate-cannot ventilate (CICV) situations do arise and may lead to dire consequences such as anoxic brain injury, cardiovascular compromise or even death.[5]

Management of an airway can be divided into four aspects: bag mask ventilation, tracheal intubation, insertion of a supraglottic airway and surgical airway. The objective of this narrative review is to appraise the evidence on predicting difficult airways in each of those four domains.

2. Pre-operative assessment

The 2013 Practice Guidelines for Management of the Difficult Airway from the ASA recommends an airway risk assessment before every anesthesia procedure.[2] Numerous approaches to the airway examination have been assessed and there are a variety of mnemonics to remember the different tests.[6]

An ideal assessment tool should be both highly sensitive (i.e. you are able to identify all of the difficult airways) and highly specific (i.e. when a difficult airway is predicted, it will likely be encountered). In actual clinical practice, the incidence of failed intubation is rare and studies need to have a large sample size to determine the predictive variables.

The pre-operative assessment starts with a focused history around the patient's previous anesthetics. A history of a difficult airway is a strong predictor of a challenging airway in the future. If a patient has had a past history of difficult airway, an effort should be made to retrieve the previous anesthetic record to determine how the airway was managed. Some patients may have a medical alert bracelet to warn

☆ Based on a presentation given at the 12th Annual Perioperative Medicine Summit (March 9th, 2017), Fort Lauderdale, FL, United States.

* Corresponding author.
E-mail address: david.wong@uhn.on.ca (D.T. Wong).

https://doi.org/10.1016/j.pcorm.2017.11.007
Received 5 October 2017; Accepted 2 November 2017

Table 1
Predictors of a difficult airway by bedside airway examination.

Airway examination component	Non-reassuring findings
Length of upper incisors	Relatively long
Relationship of maxillary and mandibular incisors during normal jaw closure	Prominent "overbite" (maxillary incisors anterior to mandibular incisors)
Relationship of maxillary and mandibular incisors during voluntary protrusion of mandible	Patient cannot bring mandibular incisors anterior to maxillary incisors
Interincisor distance	Less than two finger breadths (< 3 cm)
Visibility of uvula	Not visible when tongue is protruded with patient in sitting position
Shape of palate	Highly arched or very narrow
Compliance of mandibular space	Stiff, indurated, occupied by mass or non- resilient
Thyromental distance	Less than 3 ordinary finger breadths (< 6 cm)
Length of neck	Short
Thickness of neck	Thick
Range of motion of head and neck	Patient cannot touch tip of chin to chest or cannot extend neck

This table lists some of the physical examination findings that may suggest a difficult airway. This list is not an exhaustive or mandatory list of all the components of the airway examination. Instead, it is often up to the judgment of the airway specialist to incorporate the features that they deem most predictive of a 'difficult airway'. (Adapted from Practice Guidelines for Management of the Difficult Airway (2013).[2]

healthcare providers of a potentially challenging airway. Other parts of the focused history should include a past medical history, history of procedures and radiation to the airway, obstructive sleep apnea, previous trauma, dentition and bleeding risk/anticoagulation.

Next, a focused physical examination should be performed and documented. A routine physical examination including height, weight, and cardiorespiratory status should be completed. A focused airway exam includes examining mouth opening, thyromental distance, Mallampati class, neck extension and flexion. The goal during direct laryngoscopy is to align the 3 axes of the mouth, pharynx and larynx so that the vocal cords can be visualized and an endotracheal tube (ETT) can be inserted. Attention should also be paid to risk of airway obstruction which include drooling, stridor, dysphagia and dyspnea. A more extensive list of the components of an airway examination can be found in Table 1.

In a patient with head and neck pathology, it is often necessary to review imaging to determine the size and location of masses and abnormalities. In these patients, the anatomy of the airway is often altered and this presents certain unique challenges to the airway. For example, if a tumor is in a location where it may obstruct the airway when the patient is anesthetized, they are often intubated while awake and breathing spontaneously. Another situation that warrants review of imaging is in patients with cervical spine injury or pathology. Radiographs of flexion and extension of the cervical spine can help identify whether or not it is safe to put patients into the sniffing position for tracheal intubation.

Preoperative endoscopic airway examination is another assessment tool that can be used to predict difficult airway. In a cohort study of 138 patients undergoing elective otolaryngologic procedures, preoperative endoscopic airway examination altered the planned airway management in 26% of patients.[7] In these patients, nasal endoscopy may be useful to characterize airway pathology and change the intubation technique to asleep or awake method.

We will present the evidence for predicting difficulty with mask ventilation, intubation, supraglottic airway insertion and surgical airways.

2.1. Identifying difficult bag mask ventilation (Table 2)

After induction of general anesthesia, most patients receive bag mask ventilation. After confirmation of the ability to oxygenate and ventilate the patient, a more definitive method (i.e. tracheal intubation, supraglottic airway insertion) of securing the airway is usually implemented. Difficult mask ventilation (DMV) can been defined as the inability of an unassisted anesthesiologist to maintain oxygen saturation above 92% (as measured by pulse oximetry) or to prevent or reverse signs of inadequate ventilation under general anesthesia.[4] A distinction is made with impossible mask ventilation (IMV) which is a situation where there is no exchange of air despite multiple efforts and adjuncts.[8]

There have been a few studies that assessed the predictors of DMV. Langeron et al. [9] showed in a prospective study that 5% (75/1502) of patients had DMV. Interestingly, DMV was only anticipated by the anesthesiologist in 17% of the cases. Five independent risk factors were identified for DMV: greater than 55 years old, BMI > 26 kg/m^2, beard, lack of teeth and snoring.

In 2006, Kheterpal et al.[10] found in a prospective observational study of 22,000 anesthetics that 1.4% (n = 313) had DMV and 0.16% (n = 37) had impossible mask ventilation (IMV). Predictors of DMV included BMI > 30 kg/m^2, having a beard, Mallampati class III or IV, age older than 57 years, severely limited jaw protrusion and snoring. Moreover, predictors of IMV included snoring and thyromental distance less than 6 cm.

In a study of over 50,000 patients, Kheterpal et al. [8] examined the risk factors for impossible mask ventilation (IMV). Impossible mask ventilation was defined as "the inability to exchange air during bag-mask ventilation attempts, despite multiple providers, airway adjuvants, or neuromuscular blockade". This 4-year observational study found an IMV incidence of 0.15% (77/53,041). Five independent risk factors were identified for IMV (neck radiation changes, male sex, sleep apnea, Mallampati III or IV and presence of a beard). Neck radiation changes was the most significant predictor of IMV (hazard ratio = 7.1), which may due to changes induced by radiation impairing neck mobility to maintain a patent airway. Furthermore, IMV was also associated with 25% (19/77) of difficult intubation but only two required a surgical airway.

Walls et al. proposed the "MOANS" acronym to help remember some of the important predictors of difficult mask ventilation (Table 3).[6]

In summary, difficult mask ventilation is an infrequent event (1.4 - 5%) and impossible mask ventilation is even more rare (0.15 - 0.16%). Numerous independent risk factors for DMV and IMV have been identified with neck radiation being the most significant risk factor

Table 2
Predictors of difficult or impossible mask ventilation.

Neck radiation changes
Beard
Male gender
Sleep apnea
Mallampati class III or IV
Obesity
Edentulous
Age older than 55 years old
Facial deformities

Adapted from Ramachandran (2012).[18]