SPOTLIGHTS ON ANESTHESIA, INTENSIVE CARE & PAIN THERAPY

Second Edition

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PREFACE

Response to the first edition of this book has been extremely good. In the years since it was written, positive feedback has come from residents, practitioners, colleagues and others in the medical field.

However, advances and changes in the availability of equipment and drugs, together with changes in clinical practice, made a new edition necessary.

Anesthesiologists are increasingly responsible for the development and care of patients preoperatively and postoperatively and in the recognition and management of those who are critically ill, as well as the continuing essential role that many anesthesiologists play in treating and helping patients live with chronic pain problems. So, as with the first edition, the overall aim of this book is to present anesthesia and its related skills in terms that will help practitioners worldwide to deal effectively and safely with the needs of surgical, severely ill and critically ill patients .

The second edition of spotlights on anesthesia is presented in a completely colored format, organized into three volumes. Most of the chapters in this edition have been completely rewritten (including **1306 new illustrations and images and 500 new tables**), and there are new chapters on physics, anesthetic machines and equipment, pharmacology and pain management. The references have been extensively updated, with emphasis on recent reviews and clinical practice guidelines.

Although this edition has been completely revised, it is still based on the same principles of simplicity and practicability, using many color illustrations and photographs.

The format is designed to provide easy access to information presented in a concise manner. I have tried to eliminate as much as possible superfluous material. The style of the chapters varies. This is deliberate; some relate more to basic principles, physiology, pharmacology, etc. Others are more practical in nature, discussing the principles of anesthetic techniques for certain high-risk situations.

To reduce the variability that is the bane of multi-author texts, I am the sole author and I have personally edited every chapter in this book, to ensure consistency of style. Consequently, this book is a reflection of the workload involved that has taken me four years to complete.

I would really appreciate your feedback on my book. I am sure that even after careful review and editing, it won't be free of errors or perfectly clear to everyone who reads it. If you see ways that I can correct or improve the book, please let me know by e-mail at: **hesham@azzazianesthesia.com**. If you like certain aspects of the book, I would appreciate hearing about that, too.

Finally, I would like to say that trained people are the most valuable resource in medicine, and what you practice is what you read and learn.
So, if this book helps in any way, in improving the level of training, knowledge and practicing of anesthesia among anesthesiologists, then it will have fully achieved its goal.

Hesham El-Azzazi

DEDICATION

To all my family, to my wife and lovely children,
Ahmed and Hana and to the souls of my beloved ones

ACKNOWLEDGMENT

I would never have been able to complete this book without the friendship, support and knowledge of all my professors and colleagues. Every day, I feel how lucky I am to have been able to work with them.

Thanks to my residents and students, who drive me to improve with every minute, and my sincere appreciation to all my patients as well.

I am specially grateful to *Dr. Ahmed El Hanafi*, for his meticulous work with the illustrations, to *Dr. Sahar Talat* for her linguistic efforts, and *Dr. Lobna Habib* for reviewing all radiological material enclosed in this book.

I would also like to thank the readers of the first edition of this textbook who offered me excellent feedback that helped me add several new features to this edition.

Finally, thank you to my family, my wife and children. Thank you for reminding me daily how beautiful the world is, – even after a disenchanting day at work.

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AIRWAY MANAGEMENT

9

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  - Difficult airway and intubation
  - Extubation
- Management of the obstructed airway
- Recent airway devices and techniques

Airway management (maintaining patency of the airway) is one of the most important tasks for anesthesiologists and physicians in intensive care units. Difficult or failed airway management is the major cause of anesthesia-related morbidity and mortality.

Secure a Patent Airway

A) Mechanical Maneuvers:

They are done to remove obstruction produced by falling of the tongue (posterior placement).

1- Chin Lift-Jaw Thrust Maneuver:

It is performed by placing fingers behind the angle of the mandible on both sides and lifting the mandible forward and upward until the lower teeth or gum are in front of the upper teeth or gum. It can be done with **the neck in the neutral position,** so it can be performed if a cervical spine injury is suspected (figure 9-1).

2- Neck Lift-Head Tilt:

It is performed by tilting the head back with extension of the neck. One hand (palm) is placed on the patient's forehead applying pressure to tilt the head back while lifting the chin with the forefinger and index finger of the opposite hand. It is **contraindicated if cervical spine injury is suspected** (figure 9-2)**.**

Figure 9-1: Chin lift-jaw-thrust

Figure 9-2: Neck lift-head tilt

B) Airway Devices:

Indications:

- They relieve obstruction above the laryngopharynx caused by **loss of upper airway muscle tone (e.g., genioglossus)** as in anesthetized patients. This leads falling of the back of the tongue and the epiglottis against the posterior wall of the pharynx. Therefore, insertion of an artificial airway creates an air passage between the tongue and the posterior pharyngeal wall (figure 9-3).
- They aid in **removal of secretions** from the posterior pharynx.
- Oral types **prevent biting of the tube by the patient** during awakening from anesthesia.

Figure 9-3: Loss of airway muscle tone in an anesthetized patient causing airway obstruction (left), inserted oropharyngeal airway (middle), and inserted nasopharyngeal airway (right)

Types:

1- Oropharyngeal Airway:

• There are many sizes 000, 00, 0, 1, 2, 3, and 4. **The distance between the tip of the nose and the earlobe (or the distance between the teeth and the angle of the jaw)** approximates the correct length of an oral airway.

• The airway is inserted into the mouth with the curve pointed toward the skull then rotated 180° once the soft palate is reached.

• It may cause cough or even laryngospasm, if the laryngeal reflexes are intact in awake or lightly anesthetized patients.

• There are many types:

- **Guedel airway** is the most common (figure 9-4).
- **Berman airway** (figure 9-5). It is also available in color-coded models.
- **ChaoAirway** (figure 9-6) is formed of a rigid outer tube that serves as a conduit for and protects the inner flexible tube from biting. Both outer and inner tubes are made separately and assembled together for use.

Cuffed Oro-Pharyngeal Airway (COPA): is a modified conventional oral airway **with a large oral cuff** at its distal end. It can be connected to breathing circuits to supply anesthesia because it has the **standard 15-mm connector** (figure 9-7).

Figure 9-4: Guedel airways

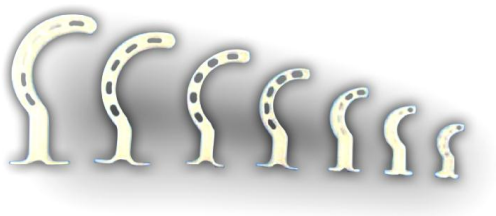

Figure 9-5: Berman airways

Figure 9-6: ChaoAirways

Figure 9-7: Cuffed oro-pharyngeal airways

There is also a device which acts a bite blocker only (not as an airway), called **airway guard** (figure 9-8). Airway guard is designed to be attached to the breathing tube for added stability and airway protection.

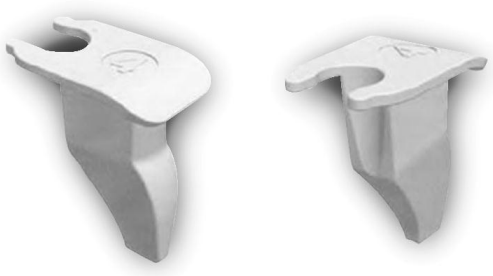

Figure 9-8: Airway guard

2- Nasopharyngeal Airway:

• It is 3-4 cm longer than an oral airway. The **correct size** is assessed by approximating the diameter of the airway to **the diameter of the patient's fifth finger** (figure 9-9).
• It is **better tolerated** than the oral types in lightly anesthetized or agitated and semiconscious patients.
• It is **more traumatizing** especially in **anticoagulated patients or in children with prominent adenoids**; therefore, it should be **lubricated** and advanced in an angle perpendicular to the face. It is **contraindicated** in patients with suspected **basilar skull fractures or coagulopathies**.
• **An adjustable nasopharyngeal airway** is a modified nasopharyngeal airway with soft movable flanges.
Other airways are discussed later.

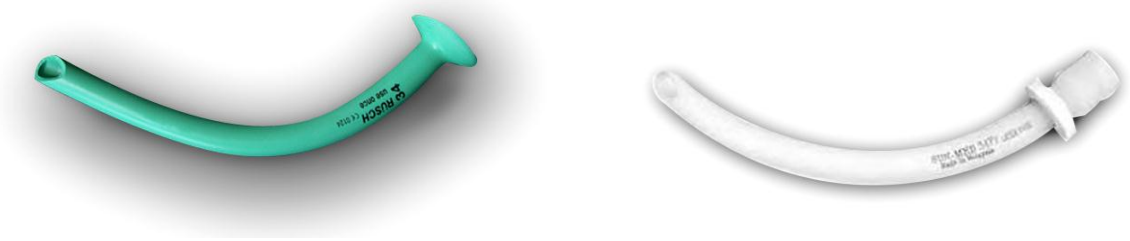

Figure 9-9: Nasopharyngeal airways: The right one is with an adjustable flange.

N.B.: Epistaxis Nasopharyngeal Airway:

It is an inflatable nasal tube, which is used to control severe hemorrhage in the nasal cavity and nasopharynx and allow bilateral stabilization of the bony cartilaginous structures after fracture of the nose. It has an anatomically contoured cuff made of silicone. The presence of silicone results in minimal adherence to the mucus membrane and a traumatic removal (figure 9-10).

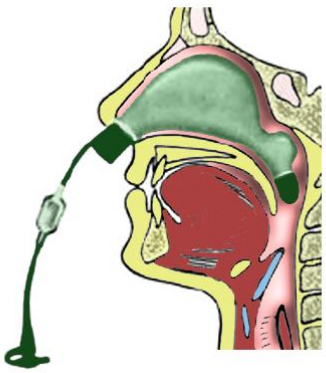

Figure 9-10: Epistaxis nasopharyngeal airway

Face Mask

Design:

There are many varieties and shapes for face masks with the following features:

• The rim of the mask is contoured and conforms to a variety of facial features allowing air-tight seal.

• Some types have **transparent bodies** which allow observation of **exhaled humidified gas, patient's skin color** and immediate recognition of **vomiting or regurgitation** (figure 9-11).

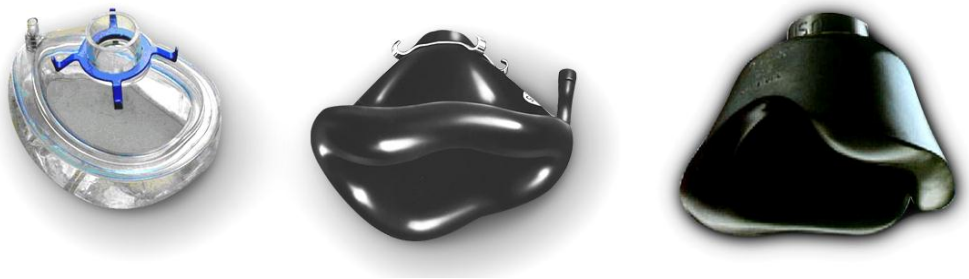

Figure 9-11: Varieties of face masks; disposable transparent (left), black reusable rubber (middle), and Everseal mask (right)

• The smallest size possible should be used to decrease the volume of dead space. Some pediatric masks are especially designed (with a shallow body) to decrease apparatus dead space as the **Rendell-Baker-Soucek pediatric face mask** (figure 9-12)**.**

• **Retaining hooks** surrounding the 22-mm orifice can be attached to a head strap **"harness system" e.g., Clausen harness**, allowing the mask to be held in place without needing the anesthesiologist (figure 9-13).

Figure 9-12: A pediatric Rendell-Baker-Soucek mask

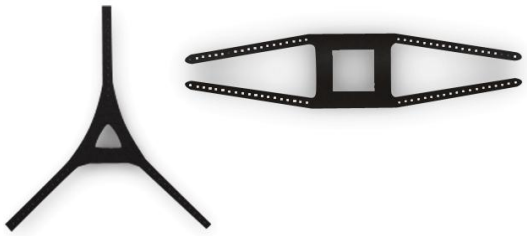

Figure 9-13: Harnesses; Clausen harness (left) and four point harness (right)

Technique:

a- One-Handed Face Mask Technique:

• The mask is held with the left hand allowing the right hand to generate positive pressure ventilation by squeezing the breathing bag.

• The mask is held against the face by the left thumb and index finger, while the middle and ring fingers grasp the mandible to extend the atlanto-occipital joint. Finger pressure should be placed on the bony mandible and not on the soft tissues supporting the base of the tongue; otherwise, the airway will be obstructed especially in pediatrics. The little finger slides under the angle of the jaw and thrusts it anteriorly.

b- Two-Handed Face Mask Technique:

• This technique is performed in difficult situations such as edentulous patients. Leaving dentures in place or packing the buccal cavity with gauze may help.

• Two hands are used to hold the mask to provide adequate jaw thrust (i.e., holding the mandible forward) and create a mask seal. Therefore, an assistant is needed to squeeze the breathing bag. In this case, the thumbs hold the mask down, while the finger tips or knuckles displace the jaw forward (figure 9-14).

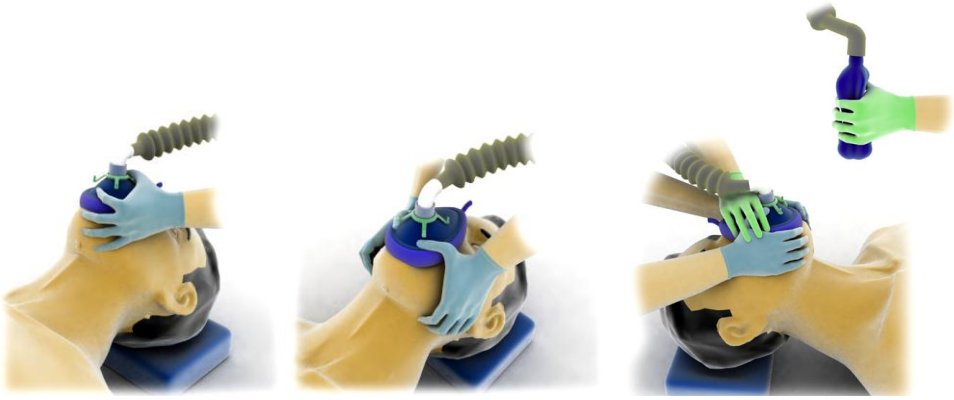

Figure 9-14: Techniques of face mask application: one-handed technique (left), two handed technique (middle), and three-handed technique (right).

c- Three-Handed Face Mask Technique:

• The two hands of the anesthesiologist and one hand of the assistant hold the mask, while the other hand of the assistant is needed to squeeze the bag.

• An oropharyngeal (Guedel) airway or a nasopharyngeal airway (better tolerated) may be used to assess patency of airway, but adequate stages of anesthesia should be reached; otherwise, coughing, laryngospasm, or breath-holding may occur.

Optimal/Best Mask Ventilation Attempts should be performed before using the emergency pathway of the difficult intubation algorithm (see later) i.e., inadequate mask ventilation in patients with difficult ventilation. This is achieved by using either the 2-handed effort or 3-handed effort as above, in addition to the use of a large oropharyngeal or nasopharyngeal airway.

Risk Factors of Suspected Difficult Mask Ventilation:

1- Age > 55 years.
2- Body mass index > 26 kg/m^2.
3- History of snoring.
4- Edentulous patients (without teeth).
5- Facial hair (a beard).

Complications:

1- Mask ventilation **may inflate the stomach;** therefore, avoid positive pressure ventilation more than 20 cmH_2O.

2- Long periods of mask support **may cause pressure injury** to branches of trigeminal or facial nerves, therefore, the mask and harness or face straps' position should be changed regularly.

3- **Corneal abrasion and pressure on the eyes** may occur.

Nasal Mask

It is may be used during dental anesthesia (figure 9-15).

Figure 9-15: A nasal black rubber mask

Laryngoscopy and Intubation

Endotracheal Tubes

Design:

- They are made of: - polyvinyl chloride (PVC) that are disposable (the most common).
  or - red rubber that are reusable and autoclavable (obsolete).
- Tracheal tubes marked I.T. or Z-79 is implant-tested to ensure nontoxicity.
- A hole (**the Murphy eye**) is present to decrease the risk of complete tube occlusion.
- **The size of the endotracheal tube** is usually designated in **millimeters of internal diameter** (or less commonly in the French scale which is the external circumference of the tube in millimeters i.e., the external diameter multiplied by 22/7).
- **The length of the endotracheal tube** exceeds that required normally for oral intubation and the tube **should be cut** to the appropriate length **before use** (figure 9-16).
- Most adult endotracheal tubes have a **cuff inflation system** consisting of a valve, pilot balloon, inflating tube, and cuff. The valve prevents air loss after cuff inflation. The pilot balloon provides a gross indication of cuff inflation. The cuff creates a seal allowing positive pressure ventilation and decreases the risk of aspiration. **Uncuffed tubes** are usually used **in children** (up to 6-8 year old) to decrease the risk of pressure injury and post-intubation croup (edema). The cuff is not required because the larynx of pediatric patients is funnel shaped with the narrowest part at the cricoid cartilage (in adults, the vocal cords are the narrowest part); in addition to the loose submucosa in pediatrics which make the edema very likely to occur.
- The anesthetic circuit and the tracheal tube can be supported by a special tube support (figure 9-17).

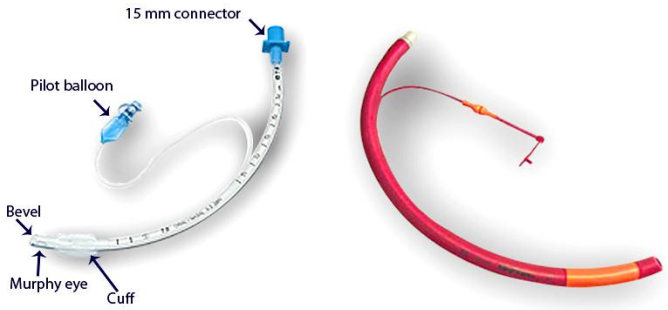

Figure 9-16: Endotracheal tubes; reusable red rubber (left) and disposable PVC tube (right)

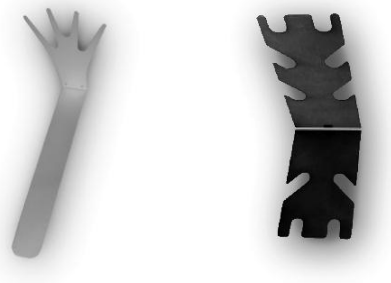

Figure 9-17: Tube supports

Types of Cuffs:

a- High Pressure (Low Volume) Cuff:

It is present mainly in the red rubber tubes and produces better seal, but the cuff produces **more severe ischemic damage** to the tracheal mucosa as the pressure inside the cuff exceeds that of the capillaries in the tracheal mucosa; therefore, it is less suitable for long operations or long stay in the intensive care.

b- Low Pressure (High Volume) Cuff:

It is present mainly in the disposable PVC tubes and produces more sore throat (as there is a larger mucosal contact area), and may cause aspiration, spontaneous extubation and difficult insertion (due to floppy cuff), but it produces **less severe ischemic damage** to the tracheal mucosa; therefore, it is more recommended especially for long operations or long stay in the intensive care. It is the most commonly used (figure 9-18).

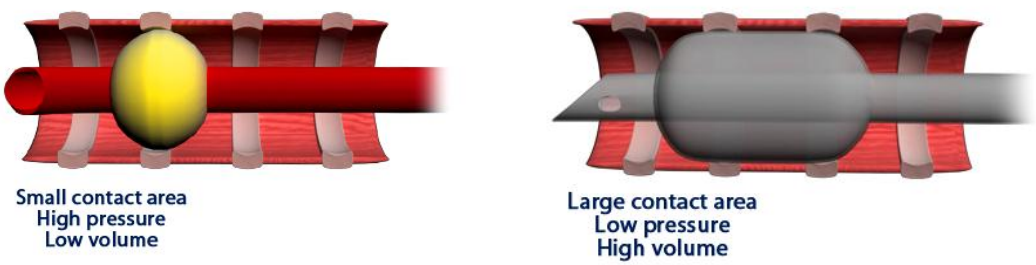

Figure 9-18: Types of cuffs; high pressure low volume (left) and low pressure high volume (right)

Cuff pressure depends on:

1- Inflation volume.
2- The diameter of the cuff in relation to the trachea.
3- Tracheal and cuff compliance.
4- Intrathoracic pressure (as cuff pressure increases with coughing).
5- N_2O diffusion from the tracheal mucosa into the cuff which causes an increase of cuff pressure; therefore, it is recommended to readjust cuff volume after 10-15 min or fill the cuff with O_2/N_2O mixture.

Monitoring of the cuff pressure is done by **a cuff manometer** (**cuff pressure gauge**) (figure 9-19), but it is not reliable because the cuff pressure may fluctuate when high pressures are used to overcome poor lung compliance.

Figure 9-19: A cuff manometer and inflator

Specialized Tube Types:

1- **Armored Tube:** It is flexible and wire-reinforced.
Advantage: It resists kinking; therefore, it is used in head and neck surgery or in abnormal positions as prone position.
Disadvantage: It may be kinked by extreme pressure e.g., biting by an awake patient because the lumen will tend to remain occluded and the tube will need replacement. Most of the armored tubes are very malleable and need a stylet for their insertion (figure 9-20).

2- **Ring-Adair-Elwyn (RAE) Preformed Tracheal Tubes (Oral and Nasal):** They have been designed, in 1975, by Wallace H Ring, John C Adair, and Richard A Elwyn. They are used to direct the breathing circuit away from the field of surgery in head and neck surgery with decreasing the risk of kinking. **The RAE oral tubes** direct the breathing circuit to the feet of the patient (sometimes it is called **south-facing**) while the **RAE nasal tubes** direct the breathing circuit to the head of the patient (sometimes it is called **north-facing**) (figure 9-21).

Figure 9-20: An armored endotracheal tube with a stylet

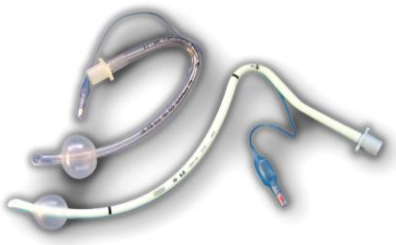

Figure 9-21: RAE performed tubes; Oral (left), nasal (right)

3- **Oxford Tube:** It is L-shaped and its distal end has a fixed length (figure 9-22); therefore, it has the advantages of: - a decreased risk of bronchial intubation.
and - a decreased risk of kinking with flexed head during surgery.

4- **Parker Flex-Tip Tracheal Tube:** It has a soft, flexible, curved, centered, distal tip that is designed to prevent trauma to the delicate structures of the airway. The tip, which is flanked by double Murphy eyes, flexes and yields as it is advanced into contact with protruding features of the airway anatomy (figure 9-23).

Figure 9-22: An Oxford non-kinking cuffed tracheal tube

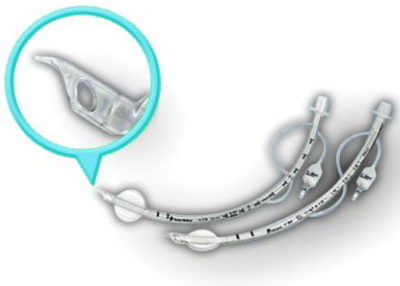

Figure 9-23: Parker Flex-Tip Tracheal tubes

5- **Laryngectomy Tube:** It is used during laryngectomy as it cannot be slipped easily during the procedure, as it is curved at its distal end, unlike the REA oral tube (figure 9-24).

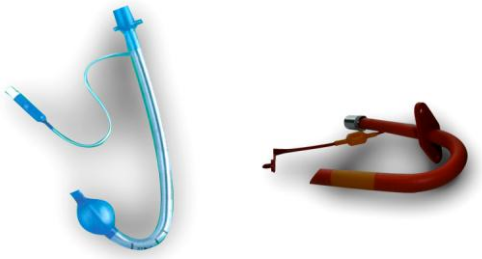

Figure 9-24: Laryngectomy tubes; PVC tube (left) and red rubber tube (right)

6- **Micro-Laryngeal Tube:** It has a small diameter to provide maximum access to the operative field although its length is comparable to a standard tube with 8 mm internal diameter (figure 9-25).

Figure 9-25: A microlaryngeal tube

7- **Laser Resistant Endotracheal Tubes:** They are used for laser surgery. They have two cuffs (figure 9-26). They are discussed in more details in "Chapter of Anesthesia & Otorhinolaryngologic Surgery".

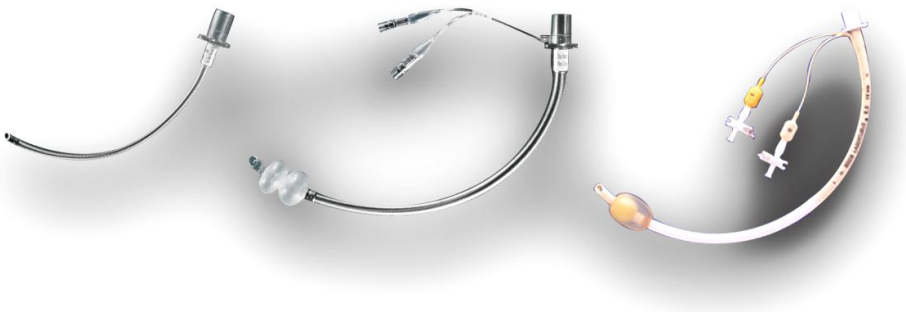

Figure 9-26: Laser endotracheal tubes

8- **Evac Endotracheal Tube:** It has an integral suction lumen and evacuation port that provide a convenient way for continuous suctioning of the subglottic area. Continuous aspiration of the subglottic secretions helps to eliminate the source of contaminated secretions above the cuff. Therefore, this tube decreases incidence of ventilator-associated pneumonia (figure 9-27).

9- **Boussionac Cardio-Pulmonary (CPR) Tube:**

This tube is used during cardio-pulmonary resuscitation as there are 5 micro-capillaries moulded into the wall of the tube. When oxygen is injected through these capillaries, turbulence is created in the distal end of the tube, creating a virtual valve. Continuous insufflation of 15 liters/min of oxygen into these capillaries generates intra-pulmonary pressure of 10 cm H_2O. This is important during cardiac massage as it is not necessary to interrupt cardiac massage for performing ventilation especially if a single person is performing the resuscitation. The continuous flow of oxygen also allows satisfactory CO_2 elimination due to constant dead space washout. This also improves the quality of the alveolar air as the oxygen exits close to the carina.

There are also two capillaries for capnography and/or pressure monitoring and/or injecting medication intra-tracheally as adrenaline (figure 9-28).

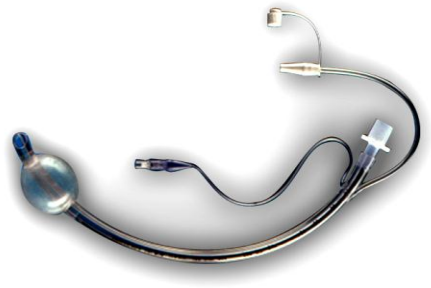

Figure 9-27: An Evac Endotracheal tube

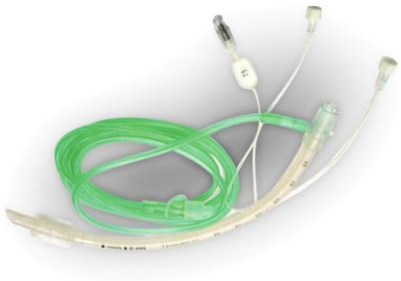

Figure 9-28: A Boussionac Cardio-pulmonary (CPR) tube

10- **Electromyograph (EMG) endotracheal tube:** It has two surface electrodes that allow monitoring of vocal cords and recurrent laryngeal nerve electromyography (EMG) activity during surgery (figure 9-29).

11- **Cole Tracheal Tube:** It is used in newborns. It has a narrow lumen at its distal portion and a wider lumen at its proximal portion to reduce air resistance to air flow, but it can injure the larynx by its narrow distal portion (figure 9-30).

12- **Jackson Rees Tube:** it a pediatric tube, which is presented in different sizes 2.5-6.5 with a connector at its proximal end with an aspiration channel to allow aspiration (figure 9-31).

Figure 9-29: An EMG tube

Figure 9-30: A Cole tube

Figure 9-31: A Jackson Rees Tube

13- **Double Lumen Tubes and tubes for one-lung separation:** are discussed later in the chapter of "Thoracic Surgery".

14- **Tracheostomy Tubes** (see later).

Rigid Laryngoscopes

They are instruments used for direct examination of the larynx and intubating the trachea.

Types of Blades:

There are many types of the blades and laryngoscopes. Most of the ordinary laryngoscopes have either curved or straight blades. More recent laryngoscopes and blades are discussed later.

	Curved Blade	Straight Blade
Technique	- The blade is introduced to the base of epiglottis at the vallecula then it is elevated forward pressuring on the hyo-epiglottic ligament to elevate the epiglottis and expose the vocal cords. - The blade touches the upper surface of epiglottis (supplied by the glosso-pharyngeal nerve) (figure 9-32).	- The blade is introduced under the lower surface of the epiglottis then it is elevated forward lifting the epiglottis to expose the vocal cord. - The blade touches the lower posterior surface of epiglottis (supplied by the vagus) (figure 9-33).
Indications	- In patients with small upper airway room to pass the endotracheal tube e.g., small narrow mouth, palate or oropharynx.	- In patients with small mandibular space (i.e., anterior larynx), large incisors, or large infantile U-shaped floppy epiglottis. - In infants with large infantile epiglottis (figure 9-34)
Disadvantages	- It is useless with large floppy infantile U-shaped epiglottis.	- As it touches the lower posterior surface of the epiglottis, it stimulates the vagus causing bradycardia and spasm. Therefore, anticholinergics are essential before its usage especially in pediatrics.
Examples	• English Machintosh blade (the most common): There are 4 sizes (figure 9-35). There is a disposable blade (figure 9-36) • American Machintosh blade (figure 9-37). • Left-handed Macintosh blade: is designed for left handed physicians (figure 9-38). • Machintosh Polio blade: is designed for patients with large breasts (figure 9-39). • Flange-less Machintosh blade (figure 9-40) is used to enhance viewing and reduce trauma. • Blechman laryngoscope blade (figure 9-41) with an angled tip is used to further elevate the epiglottis. The flange near the tip is removed to enhance viewing. • Siker Mirror American blade (figure 9-42).	• American Miller blade: There are 4 sizes (figure 9-43). • English Miller blade (figure 9-44). • Wisconsin blade: There are 5 sizes (figure 9-45). • Oxford blade: There is one size only for infants (figure 9-46). • Robertshaw blade: There are 2 sizes for infants and children (figure 9-47). • Soper blade: There are 3 sizes (figure 9-48). • Seward blade: There is one size for children (figure 9-49). • Phillips blade (figure 9-50). • Snow American blade (figure 9-51) • Henderson blade: is a new blade, with an improved tip and light and with larger cross-sectional area (figure 9-52).

For more other recent devices used for intubation and ventilation see later.

Figure 9-32: A curved blade

Figure 9-33: A straight blade

Figure 9-34: Larynx of adult (left) and infant (right)

Figure 9-35: An English Macintosh blade

Figure 9-36: Disposable Macintosh and Miller blades

Figure 9-37: An American Macintosh blade

Figure 9-38: A left-handed Macintosh blade

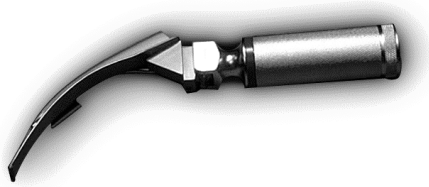

Figure 9-39: A Macintosh polio blade and handle

Figure 9-40: Flangeless Machintosh blade

Figure 9-41: Blechman laryngoscope blade

Figure 9-42: A Siker Mirror American blade

Figure 9-43: An American Miller blade

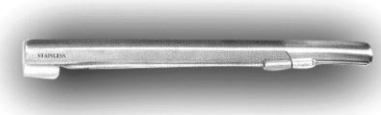

Figure 9-44: An English Miller blade

Figure 9-45: A Wisconsin blade

Figure 9-46: An Oxford blade

Figure 9-47: A Robertshaw blade

Figure 9-48: A Soper blade

Figure 9-49: A Seward blade

Figure 9-50: A Phillips blade

Figure 9-51: A Snow American blade

Figure 9-52: Henderson blades

Indications of Intubation:

1- Provision of **a clear airway** e.g., anticipated difficulty in using mask anesthesia in an edentulous patient or other causes of airway obstruction such as laryngeal edema or trauma.
2- An **unusual position** anesthesia e.g., prone or sitting.
3- An operative site near or involving the upper airway such as **head, neck, or thoracic surgeries**.
4- **Protection** of the respiratory tract **against aspiration.**
5- The need for **mechanical ventilation** and muscle relaxants e.g., respiratory failure.
6- Facilitation of **suction** from the respiratory tract.

Technique of Intubation

Preparation for Rigid Laryngoscopy:

A) Checking of Equipment:

1- The Endotracheal Tube: should be examined for the following points:

• The size: The proper size is chosen according to the following table, but this is only approximation; therefore, one size above and one size below should be available.

To be continued in the hard copy of the book