

Anesthesia Toolbox

Sample Mini PBLD

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Airway Mini PBLD 1: Endotracheal Tube Exchange (14 pt)

Instructor Version

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Disclosures: None

Learning Objectives:

Upon completion of this learning activity, participants will be able to:

1. Identify indications for exchange of an endotracheal tube (ETT)
2. Assess and plan ETT exchange
3. Identify different ways to exchange an ETT with advantages and disadvantages
4. Identify complications associated with ETT exchange

Case 1:

A 51-year-old male patient with traumatic cervical neck injury has been intubated and is on volume control mechanical ventilation in ICU. The set tidal volume on ventilator is 450ml. The alarm keeps sounding with expired volume on the ventilator fluctuating anywhere between 150 -200ml.

1. You are called to the ICU to assist. How do you trouble shoot?

- *The discrepancy between the set tidal volume and expired tidal volume is suspicious for a cuff leak.*
- *Cuff leak can be diagnosed by
 - *Audible sound – a large leak may present as an audible sound at the mouth. Alternatively, a stethoscope can be placed in the neck over thyroid cartilage to listen for harsh turbulent sounds from a leak. Smaller leaks may only manifest at higher peak airway pressures. When using an anesthesia machine, the pressure at which leak occurs can be easily found by holding the adjustable pressure –limiting valve (APL valve) to a certain**

pressure and listening with a stethoscope. On the other hand, this method can also be used to prevent excessive cuff inflation especially in pediatric patients.

- *Loss of tidal volume with failure to achieve set minute ventilation (i.e., the recorded expired volume is lower than the set tidal volume)*

2. Can you describe the different reasons for an endotracheal cuff leak?

- *Cuff leak can be classified broadly into following categories.*
 - *Leaks due to a defective pilot balloon or inflation tube – There may be visible damage found on close inspection or the one way valve may be defective leading to inability to inflate the pilot balloon. Needs either repair of the inflation system or ETT exchange. Repair of pilot tube/balloon can be done easily by different techniques. A pilot tube repair kit is commercially available from Instrumentation Industries, Inc. which has a pilot balloon attached to a tube and tapered needle that can be inserted into the intact portion of a severed pilot tube. Alternatively, a 22G intravenous catheter or epidural catheters have been used as makeshift repair devices. Dayan et al tested the structural integrity of using a 22G intravenous catheter for this purpose. A 22G catheter is inserted into the severed end of inflation line and the needle is withdrawn. The hub is then cut leaving the catheter attached to the inflation line. A new pilot balloon with inflation tube is then cut from an intact tracheal tube and the tip is dilated using another 22G catheter needle. It is then connected to the proximal protruding end of the catheter to complete the new assembly acting as a stent. This was found to be an effective temporizing measure in their study. (Dayan,2016)*
 - *Leaks due to a defective cuff - Leak would persist despite conservative measures described above. Needs definite ETT exchange*
 - *Leaks around intact cuff/inflation system- Needs troubleshooting before the decision of ETT exchange.*
- *Most common causes of leaks around intact cuff/inflation system are*
 - *Cuff under-inflation (Check cuff pressure manually with syringe or manometer)*
 - *Cephalad migration of the ETT, sometimes balloon is between or above the vocal cords. (Check with Xray or DL or bronchoscopy)*
 - *Tracheal misplacement of oro/nasogastric tubes*
 - *Discrepancy between ETT and tracheal diameter (occasionally the balloon will "soften" over time, or some patients have tracheomalacia)*
 - *High peak airway pressures (Change the ventilator setting, decrease peak airway pressure)*

3. Your attempts to re-inflate the cuff are unsuccessful. X-ray reveals that the position of the tube is unchanged from the time of intubation. How will you proceed?

- *The cuff leak is probably from a damaged cuff/inflation system and would need a change of ETT.*
- *Cuff leak is the most common indication to exchange ETT. The incidence of cuff leak in ICU is 6-11% (El-Orbany, 2013).*

- *Other indications for exchanging an endotracheal tube.*
 - *Inappropriate size*
 - *Increase in size for bronchoscopy*
 - *Exchange of double lumen tube (DLT) with a single lumen tube (SLT)*
 - *Exchange of SLT with DLT (for single lung ventilation for massive hemoptysis)*
 - *Exchange of nasal ETT to oral ETT or vice versa*
 - *Completely blocked ETT*
 - *ETT damage (E.g., biting/chewing by the patient)*

4. How would you assess the airway and prepare for the exchange?

- *The risk of airway loss and reintubation failure is present in any ETT exchange procedure. ICU patients are particularly at higher risk for complications due to potential for airway edema, full stomach, difficult airway positioning and reduced cardiopulmonary reserve. It can be life threatening for patients who are ventilator dependent, especially requiring high FiO₂ or PEEP.*
- *Assessment before ETT exchange should include 3 components*
 - *History – history of prior difficult airway, cervical spine injuries/disease, changes to airway due to surgery/trauma, airway edema, and neck contractures all point to difficult ETT exchange*
 - *Airway examination – Routine airway examination to look for markers of difficult intubation should be done prior to ETT exchange. The ETT exchange can be difficult even if the 1st intubation was easy as patient's clinical status could have changed from the time of 1st intubation.*
 - *Pre-exchange laryngoscopy – Direct laryngoscopy (DL) or video-assisted laryngoscopy (VAL) prior to ETT exchange or as an adjunct during ETT exchange is very valuable and provides the best assessment of patient's airway. It can provide information on airway edema, secretions and ease of visualization of the vocal cords which can help to delineate high risk ETT exchanges from low risk ones. This information can be used to formulate the primary and backup plans for ETT exchange. It can also help diagnose unexpected causes of air leaks such as partial or complete tracheal extubation which can masquerade as cuff leak. Partial or complete tracheal extubation is an emergency which will require reintubation with the same or a different ETT rather than an exchange.*
- *This patient has a difficult airway due to cervical injury and will be considered a high-risk exchange. ETT exchange, especially high-risk ones should be carried out by a team of airway experts with primary and alternative strategies clearly planned prior to the procedure in accordance with the American Society of Anesthesiologists (ASA) difficult airway algorithm. Whenever possible, proper positioning of the patient (e.g., Sniffing position, ramped up position for obese patients) to align the 3 airway axes should be done prior to the procedure. In patients with cervical injury, this is not possible and manual inline stabilization should be maintained throughout the procedure. In suspected difficult airway patients, personnel trained in surgical airway access should be readily available.*

5. After knowing that the patient was easy to intubate the first time and had a good airway exam, you decided to exchange ETT with direct laryngoscopy. After manual inline stabilization, you were able to visualize vocal cords and ETT. After

removing previous ETT you noticed that it is grade III view of Cormack Lehane. Nonetheless you decided to go ahead and try to intubate, however, It was an esophageal intubation and now the patient's saturation started dropping. How could you have prevented this from happening?

Different approaches by which you can exchange the ETT in this patient, each with pros and cons.

- *Direct laryngoscopy - Assess the airway using direct laryngoscopy, if vocal cords and ETT well visualized then ETT can be exchanged under direct visualization. The risk of reintubation failure and airway loss can be high with the use of DL alone. One retrospective analysis reported higher rates of complications and first past re-intubation rate of only 49.4% when DL alone was used for exchange.*
- *Video laryngoscopy – VAL appears to be a better tool than DL alone for ETT exchange. VAL improves the glottis view and reduces the rate of failed intubations especially in patients with difficult airway (Mort, 2015).*
- *Replacing ETT with an introducer – Introducers such as gum-elastic bougie, Eschmann tracheal tube introducer or Mizus Metro® endotracheal tube replacement obturator can be used for ETT exchange. The disadvantage is the inability to provide supplemental oxygen due to the solid core.*
- *Airway exchange catheters (AEC) -These are semi-rigid, hollow devices through which supplemental oxygen can be administered and continuous airway access can be maintained throughout the procedure. There are many types, but the two most commonly used ones are -*
 - *Cook® airway exchange catheter -It is a long, thin, flexible catheter with straight rounded tip. It can be re-usable or of single use. It is available in 8Fr, 11Fr, 14Fr and 19Fr sizes with different lengths (500-700mm). It has hollow central lumen with a distal side hole and has Rapi-Fit® adapter- either a 15 mm or leur-lock jet connection at the proximal end for oxygen delivery (See images 1 and 2).*
 - *Aintree Intubation Catheter (AIC) (19Fr) is an adaptation of Cook Airway Exchange Catheter. Its larger internal diameter (ID) of 4.7 mm is flexible enough to allow it to be pre-loaded onto a fiberoptic bronchoscope (up to 4.2 mm size). Its external diameter is of 6.5 mm and allows ET tube of 7 mm ID or larger to railroad over it.*
- *Fiberoptic bronchoscope (FOB) guided exchange – Fiberoptic bronchoscope loaded with ETT or AIC can be used for ETT exchange by passing the bronchoscope into the trachea beside the existing ETT. An AEC can be placed inside the existing ETT prior to removal for maintaining continuous airway access.*
- *Combinations of airway exchange catheter with DL or VAL or FOB have been successfully used for ETT exchange.*
- *Exchange of oral to nasal ETT – Various methods have been described to perform oral to nasal and nasal to oral ETT exchange. The following method ensures continuous airway access for a safe exchange.
First, an airway exchange catheter is introduced nasally and placed into the trachea alongside the existing oral ETT under FOB/DL or VAL guidance. Then, another airway exchange catheter is passed through the oral ETT and the ETT*

is pulled out of the trachea leaving both AEC in place. The new nasal ETT can then be advanced over the nasal AEC. Both the exchange catheters are then removed.

Alternatively, instead of the nasal AEC, a FOB loaded with ETT can be placed nasally with the tip in trachea before introduction of AEC through the oral ETT. Then the oral ETT is removed leaving the oral AEC for continuous airway access. Now the nasal ETT can be advanced over the nasally placed FOB. The FOB and the oral AEC are then removed.

Exchange of nasal to oral ETT can be done in a similar fashion.

Table 1. Different methods of ETT exchange

Method of ETT exchange	Airway exchange catheter
Direct laryngoscopy	+/-
Video assisted laryngoscopy	+/-
Fiberoptic bronchoscope alongside the existing ETT	+/-
Combined FOB + VAL/DL	+/-
Nasal to oral/ vice versa	+/-
DLT to SLT /vice versa	+/-
No laryngoscopy	AEC alone

Adapted from Mort TC, Surette A-M. *ETT Exchange in the ICU* [Internet]. Anesthesiology News. 2017 [cited 2020 Apr 19]. Available from:

<https://www.anesthesiologynews.com/Review-Articles/Article/08-17/ETT-Exchange-in-the-ICU/42257>

6. The medical student with you wanted to learn more and asked, “what else can go wrong during the procedure”? What do you tell her?

- *Patients with difficult airway and decreased cardiopulmonary reserve are at greatest risk of complications during exchange of an endotracheal tube. The potential complications that can occur are:*
 - *Re-intubation failure and loss of airway*
 - *Need for surgical airway*
 - *Desaturation and severe hypoxia*
 - *Airway edema and airway injuries*
 - *Bradycardia*
 - *Cardiac arrest*
 - *Barotrauma and pneumothorax from jet ventilation through airway exchange catheter*

7. Assume a 11 Fr airway exchange catheter (AEC) is used for ETT exchange. The AEC is inserted up to the 35 cm mark and the ETT is removed. A new 7.5 ETT is passed over the exchange catheter. There is difficulty passing the new ETT beyond 15cm at the lip and it is getting stuck midway. How would you proceed?

- *The ETT is likely getting stuck in the laryngeal inlet due to bevel impingement on the vocal cord or arytenoid cartilage. Difficulty passing the ETT over AEC can especially happen when a small size AEC is used in conjunction with a larger ETT.*
- *Measures that can be taken to minimize difficulty in passing ETT are as follows*

- *Withdrawal of ETT by 2cm and re-attempt after counterclockwise rotation of ETT by 90 degrees*
- *Minimizing the gap between the sizes of AEC and ETT. A relatively smaller ETT with a relatively larger AEC allows for a smoother passage of ETT*
- *Combining AEC exchange with DL/VAL to visualize the glottis and aid in passage of the ETT. A combination of laryngoscopy and AEC is associated with a higher success during ETT exchange than either method used alone. Between DL and VAL, usage of VAL+AEC is superior and leads to fewer attempts and fewer airway / hemodynamic complications*

8. Assume an airway exchange catheter with jet ventilation was used for ETT exchange. Ten minutes later, the patient is hypotensive and has increasing oxygen requirements. How would you evaluate? How would you avoid such complication in future?

- *Air entry should be checked bilaterally. The patient could have a pneumothorax which is a rare complication of using jet ventilation through the AEC. A chest X ray should be obtained immediately and would need a chest tube placement if there is a large pneumothorax. If the patient is hemodynamically unstable and air entry is reduced on one side, tension pneumothorax should be suspected and immediate needle thoracostomy should be done,*
- *The barotrauma after jet ventilation occurs due to excessive air entry relative to air exit and can lead to tension pneumothorax, pneumomediastinum or subcutaneous emphysema. This can be minimized by limiting air entry during jet ventilation to 25 psi and limiting inspiratory time to less than 1s. Air exit can be maximized by keeping the airway open using jaw thrust maneuver or an oral airway and using a larger ETT when used in conjunction with the AEC.*
- *Other complications that can occur during use of AEC are:*
 - *Misplacement, esophageal intubation*
 - *Failure to pass ETT*
 - *Tracheobronchial trauma or lung laceration*
 - *Laryngeal or vocal cord trauma from a new ETT*

BONUS QUESTION:

A double lumen tube (DLT) is used during a thoracic surgery case. At the end of surgery, you use an AEC to exchange DLT to a single lumen tube (SLT).

Which lumen of DLT would you use to introduce the AEC? Why?

- *It is recommended that the airway exchange catheter should be introduced through the bronchial lumen of DLT as there are case reports of a rare complication of rupture or kinking/bending of AEC when it is introduced through the tracheal lumen.*
- *But while exchanging a single lumen tube to a DLT with an exchange catheter, the tracheal lumen should be introduced over the AEC for intubation.*

References and Suggested Reading: (alphabetized and numbered)

1. [Benumof JL. Airway exchange catheters: simple concept, potentially great danger. Anesthesiology. 1999;91\(2\):342-4.](#)
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4. [Lewis SR, Butler AR, Parker J, Cook TM, Smith AF. Videolaryngoscopy versus direct laryngoscopy for adult patients requiring tracheal intubation. Cochrane Database Syst Rev. 2016;11:CD011136.](#)
5. [Mort TC, Braffett BH. Conventional Versus Video Laryngoscopy for Tracheal Tube Exchange: Glottic Visualization, Success Rates, Complications, and Rescue Alternatives in the High-Risk Difficult Airway Patient. Anesth Analg. 2015;121\(2\):440-8.](#)
6. [Mort TC, Surette A-M. ETT Exchange in the ICU \[Internet\]. Anesthesiology News. 2017 \[cited 2020 Apr 19\].](#)
7. [Mort TC. Tracheal tube exchange: feasibility of continuous glottic viewing with advanced laryngoscopy assistance. Anesth Analg. 2009;108\(4\):1228-31.](#)

Image 1 - A size 7.5 endotracheal tube lined up over a Cook® airway exchange catheter(14Fr)



Image 2 -- A size 7.5 endotracheal tube alongside a Cook® airway exchange catheter(14Fr) with Rapi-Fit® adapters

