DETECTING METHODS OF ENDOTRACHEAL TUBE POSITION

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Objectives

- Review of conventional methods
- Good and Gold Standards for ETT positioning
- International recommendations
- An algorithm to confirm tube position

Endotracheal intubation is a potential minefield for disaster. Errors in its performance can be associated with high morbidity and mortality for the patient and legal liability for the practitioner.

Verification methods

- Observational verification
- Measured verification
- Anatomical verification

Observational verification

- Direct visualization
- Observation of chest movement
- Five point auscultation
- Presence of exhaled tidal volume

Observational verification

- Reservoir bag compliance
- Tube condensation with exhalation
- Absence of gastric contents within the ETT

Measured verifications

- End-tidal Carbon dioxide ($ETCO_2$)
- Pulse Oximeter

Anatomical verification

- Esophageal Detector Device (EDD)
- Chest Radiograph
- Lighted Stylet

Anatomical verification

- Sonography (USG)
- Fiberoptic Bronchoscope / Laryngoscope
- Video Assisted Laryngoscope

Direct visualization

- Non visualization of cords
- Dislodged tube (before / after securing)
- Inadvertent esophageal tube position after direct vision intubation *

** White SJ, Slovis CM. Inadvertent esophageal intubation in the field: Reliance on a fool's "gold standard". Acad Emerg Med 1997; 4: 89-91*

Chest Movement

- Obesity - decreased or absent chest excursion
- Lung diseases - decreased or absent chest excursion
- Esophageal intubation does produce some degree of chest movement *

** Cundy J. Accidental Intubation of Esophagus (letter) Anesth Intensive Care 1981; 9:76*
Ogden PN. Endotracheal Tube misplacement (letter) Anesth Intensive Care 1983; 11: 273-4

Auscultation – Axilla

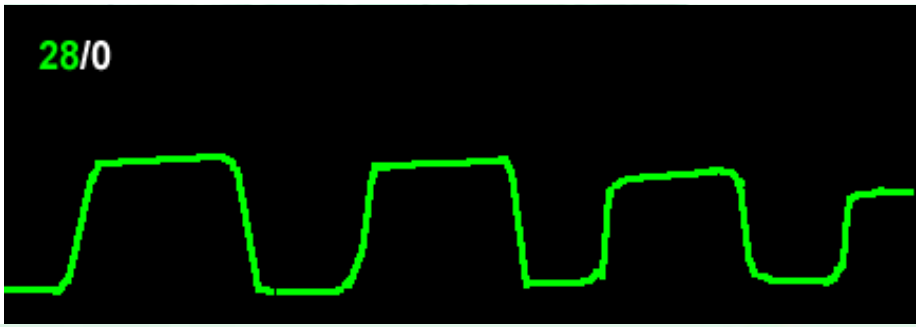
- Breath sounds may be heard in both axillae but may result in misdiagnosis in up to 15 % of all esophageal intubations*

** Linko K. Capnography for detection of accidental esophageal intubation. Acta Anesthsiol Scand 1983; 27: 199-202*

Epigastric Auscultation

- Not 100% reliable
- Gastric distention is gradual due to previous bag mask ventilation

End tidal CO_2 detection



End tidal CO_2 detection

- CO_2 in exhaled air confirms tracheal tube position in patients with spontaneous circulation *

** Takeda T. The assessment of three different methods to verify tracheal tube placement in the emergency setting. Resuscitation 56; 153, 2003.*

End tidal CO_2 detection

Cardiac arrest

- CO_2 level > 2 % - confirms tracheal tube position
- Absence of CO_2 will not rule out esophageal intubation.

** Ron M W. Airway, Rosen's Emergency Medicine Concepts and Clinical Practice, Vol 1, Sixth Edition 2006, MOSBY ELSEVIER*

$ETCO_2$ useful as an adjunct to confirm ET tube placement

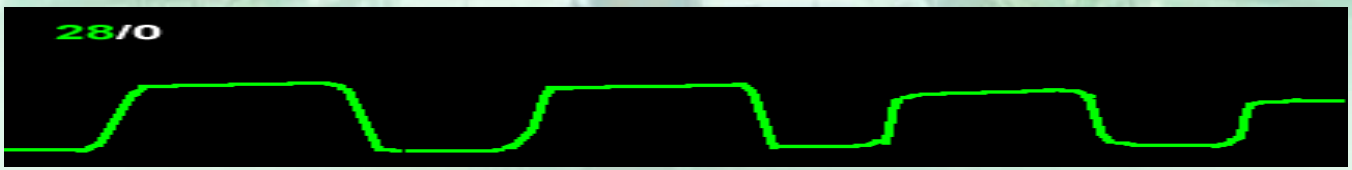
Studies	LOE
Li.J et al, J. Emerg Med. 2001	1
Germec S et al, Intensive Care Med 2002	3
Anton WR et al , Ann Emerg Med. 1991 **Varon AJ** et al, J.Clin Monit, 1991	5

End tidal CO_2 detection

- Positive predictive value (Endotracheal placement if CO_2 is detected) **100 %**
- Negative predictive value (Esophageal placement if CO_2 is *not* detected) **20-100%**

End tidal CO_2 detection

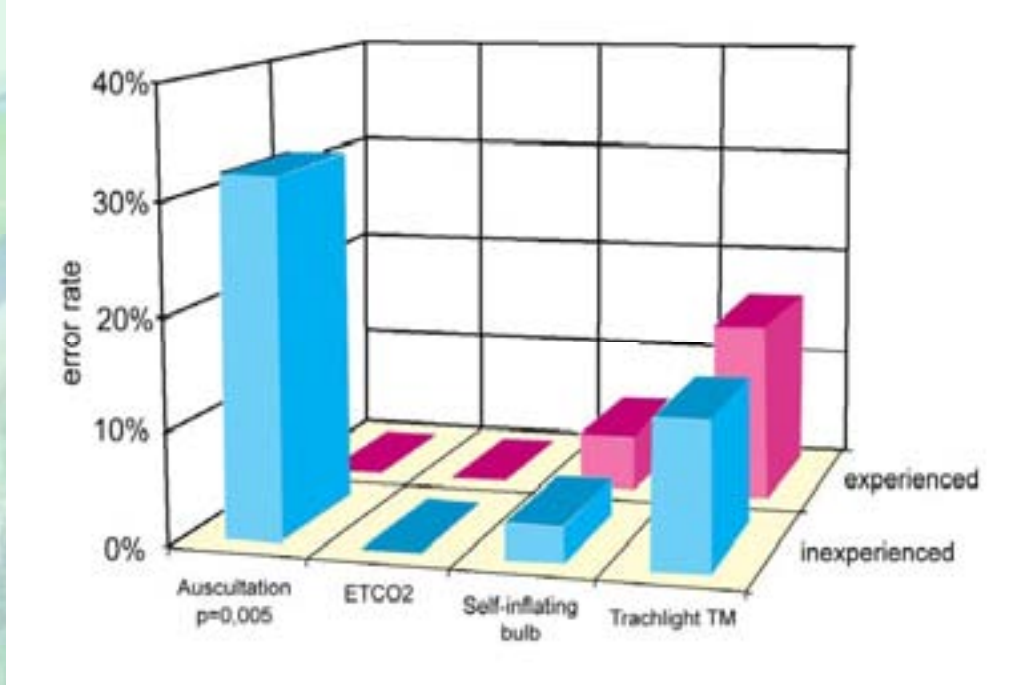
- Threshold to detect - 15 mmHg for the colorimetric capnometer
- Waveform may be detected at much lower levels with capnography



Nellcor.Easy Cap ET CO2 detector product information Hayward, CA: Nellcor, Inc 1992

End tidal CO_2 detection

- Most reliable method
- Independent of user's experience



Sylvia K. Assessment of for deferent methods to verify tracheal tube placement in critical care setting Anesth. Analg 1999; 88: 766-70

False negative reading

(Failure to detect CO_2 when tube is in the trachea)

- Low Blood flow and CO_2 delivery to lung (CPR)
- Pulmonary embolism – decreased pulmonary blood flow
- Contaminated detector – gastric content and acidic drugs like epinephrine when administered through trachea.

False negative reading

(Failure to detect CO_2 when tube is in the trachea)

- IV Epinephrine will reduce elimination and detection of CO_2 *
- Severe airway obstruction
- Status Asthmatics
- Pulmonary Edema

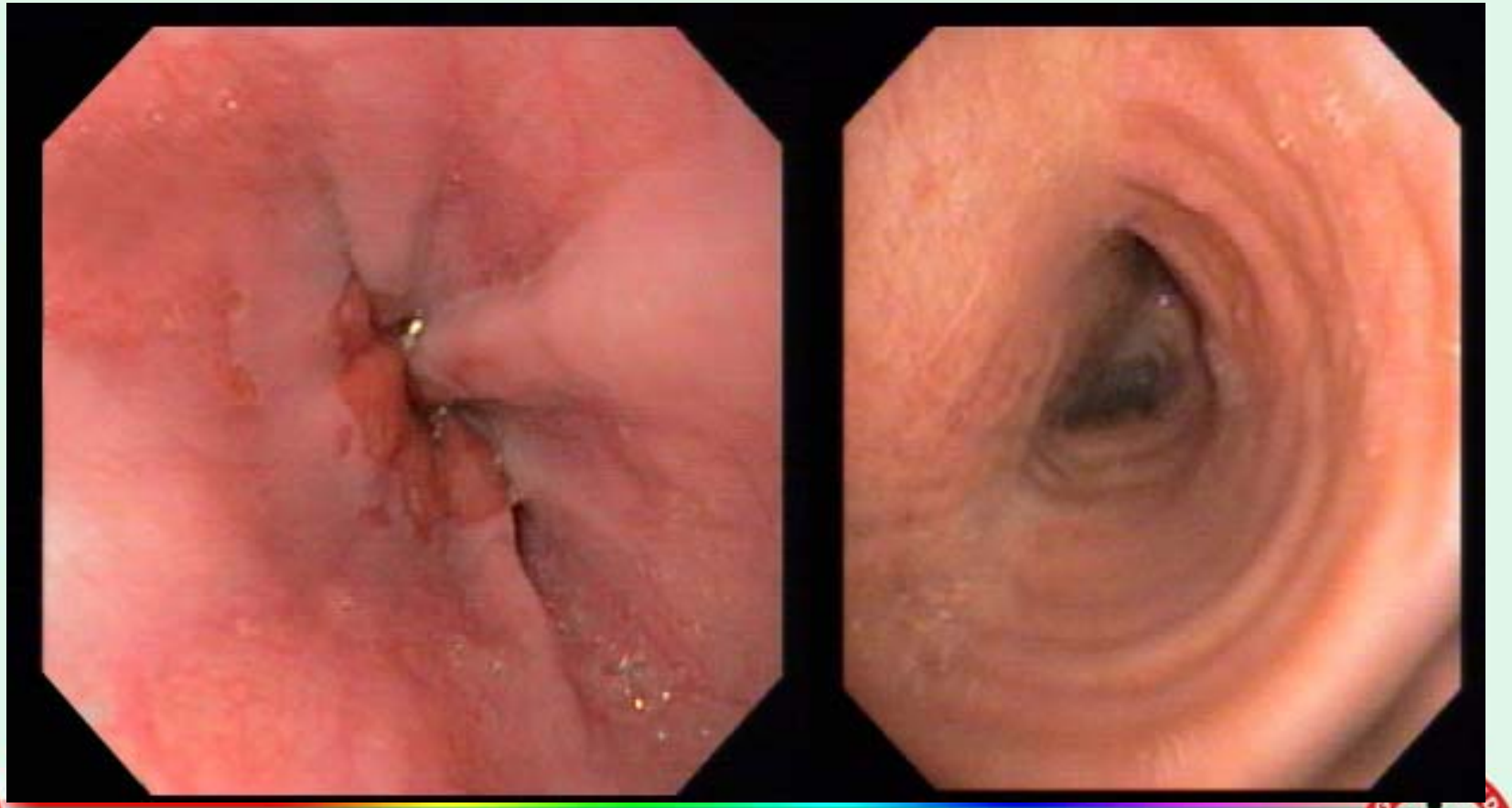
** Cantineau JP; Effect of epinephrine on end-tidal carbon dioxide pressure during pre hospital cardio pulmonary resuscitation. AmJ Emerg Med 1998; 5: 637-646*

Esophageal Detector Devices (EDD)

Esophageal Detector Devices (EDD)

- The EDD consists of a bulb that is compressed and attached to ET tube or a syringe that is attached to ETT.

Collapsible Esophagus
&
Non collapsible Trachea



Esophageal Detector Devices (EDD)

- The suction created by the EDD will collapse lumen of the esophagus and the bulb will not re expand

EDD sensitivity for esophageal tube position

Studies	LOE
Takeda T et al, Resuscitation 2003 **Pelucio M** et al, Emerg Med 1997 **Tanigwa K** et al, Anesthesiology 2000	3
Bozeman WP et al, Ann Emerg Med. 1996	5
Sherieff GQ. et al, Acad Emerg. Med 2003 **Wee MY** et al, Anesthesia. 1991 **Williams KN** et al, Anaesthesia 1989 **Zalesi L** et al, Anesthesiology 1993	7

EDD –Less specific for tracheal tube position

Studies	LOE
Haynes SR et al, Anesthesia 1990	2
Takeda T et al, Resuscitation 2003 **Tanigwa K** et al, Anesthesiology 2000	3

Esophageal Detector Devices (EDD)

- Highly sensitive for detection of esophageal intubation *
- Poor specificity for tracheal tube placement
- EDD is not accurate for continuous monitoring

** Takeda T. The assessment of three methods to verify tracheal tube placement in emergency setting. Resuscitation 2003; 56:153-157*

Pelucio M. Out-of-hospital experience with the syringe esophageal detector device Acad Emerg Med 1997; 4: 563-68

Tanigwa K. Accuracy and reliability of the self-inflating bulb to verify tracheal intubation in out-of-hospital cardiac arrest patient Anesthesiology 2000; 93: 1432-1446

EDD will be misleading

- Morbid obesity
- Late pregnancy
- Status Asthmaticus
- Copious ET Secretions
- Tracheal collapse

Pulse Oximetry

Useful

?

Pulse Oximetry

Useful

But,

Delayed !!

** Benumof J. Critical Hemoglobin desaturation will occurs before return to un paralyzed state following 1mg/kg intravenous succinyl choline. Anesthesiology 87, 979, 1997*

Chest Radiography

Primary purpose is to ensure its position below the cords and above the carina *

** Ron M W. Airway, Rosen's Emergency Medicine Concepts and Clinical Practice, Vol 1, Sixth Edition 2006, MOSBY ELSEVIER*

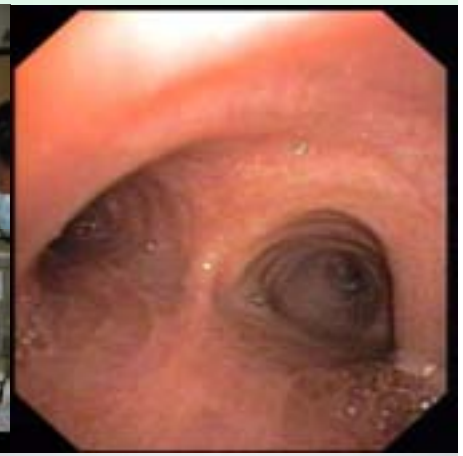
Other methods

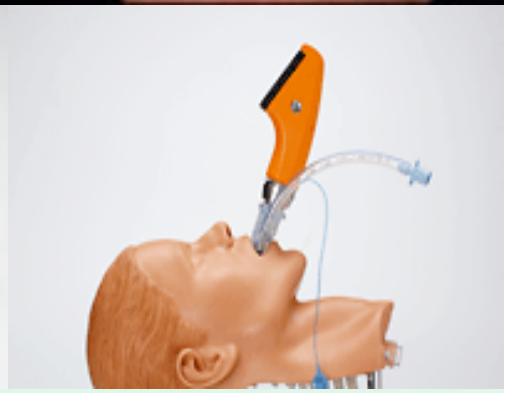
- Sonography

- Lighted Stylet

Other methods

- Fiberoptic scope
- Video Assisted Laryngoscope





International Recommendations

Emergency Medicine Journal March 2001

"Independent confirmation of correct tube placement by the use of devices that detect end-tidal CO_2 is mandatory for every endotracheal intubation performed in the emergency department and as part of the assessment of all patients who arrive at the emergency department already intubated"

** Position statement number 1.Confirmation of endotracheal tube placement with end tidal CO_2 detection. Emerg Med J 2001:18 :329, review March, 2003*

American College of Emergency Physicians (ACEP) October 2001

End-tidal CO_2 detection, either qualitative, quantitative, or continuous, is the most accurate and easily available method to monitor correct endotracheal tube position in patients who have adequate tissue perfusion *

* *Verification of endotracheal tube placement; policy statement. American College of Emergency Physicians. www.acep.org /1,4923,0.html*

National Association of EMS Physicians (NAEMPS) – Position statement 1999

In the patient with a perfusing rhythm, end-tidal CO_2 detection is the best method for verification

** O'Connor RE. Verification of endotracheal tube placement following intubation. National Association of EMS Physicians Standards and Clinical Practice committee, Pre hosp Emerg Care 1999; 3:248-50*

American Heart Association (AHA) Protocol for Advanced Cardiac Life Support [ACLS] 2002 and 2005

Expired CO_2 detectors are very reliable in patients with perfusing rhythm and are recommended to confirm tube position in these patients (Class IIa) *

** American Heart Association Resuscitation guidelines 2005, Circulation 2005; 112: IV-51-IV 57)*

Association of Anesthetists of Great Britain & Ireland and American Society for Anesthesiologists (ASA) *

- Capnography is essential to the safe conduct of anesthesia
- Continual monitoring for the presence of expired carbon dioxide shall be performed unless invalidated by the nature of the patient, procedure or equipment

** Recommendation for standard of monitoring during Anesthesia and recovery. 3rd Edition, December 2000. The Association of Anesthetists of Great Britain and Ireland. www.aagbi.org/guidelines.html*

The American Society of Anesthesiologists. Standard for Basic Anesthetic Monitoring. Approved by House of Delegates, October 1986, amended 1998. http://www.asahq.org/publicationsAndServices/standards/02.pdf#2

NRP (Neonatal Resuscitation Protocol) Guidelines 2006. Consensuses on sciences;

- Exhaled CO_2 detection is reliable indicator of ETT placement in infants and it identifies esophageal intubation faster than clinical assessment.
- NRP recommends using exhaled CO_2 detection to confirm tracheal tube placement

** (Aziz J perinatol 1999, Bhende, Pediatrics 1995, Repetto, J Perinatol 2001, Roberts, Pediatric Pulmonl 1995)*

"Despite the recommendations issued by various National organizations that endorse continues monitoring of ET CO_2 for confirming ET tube placement, it is *neither widely available nor consistently applied"*

** Delorio NM, Continuous and-tidal carbon dioxide monitoring for confirmation of endotracheal tube placement is neither widely available nor consistently applied by emergency physicians, Emerg Med J 2005; 22:490-493*

Suggesting

A

Practical

Approach !!

Intubate under direct vision
(as far as possible)

↓

Hold the ET Tube & Note down tube
markings at lip level

↓

Attach ETCO2 Detector, Start Ventilation

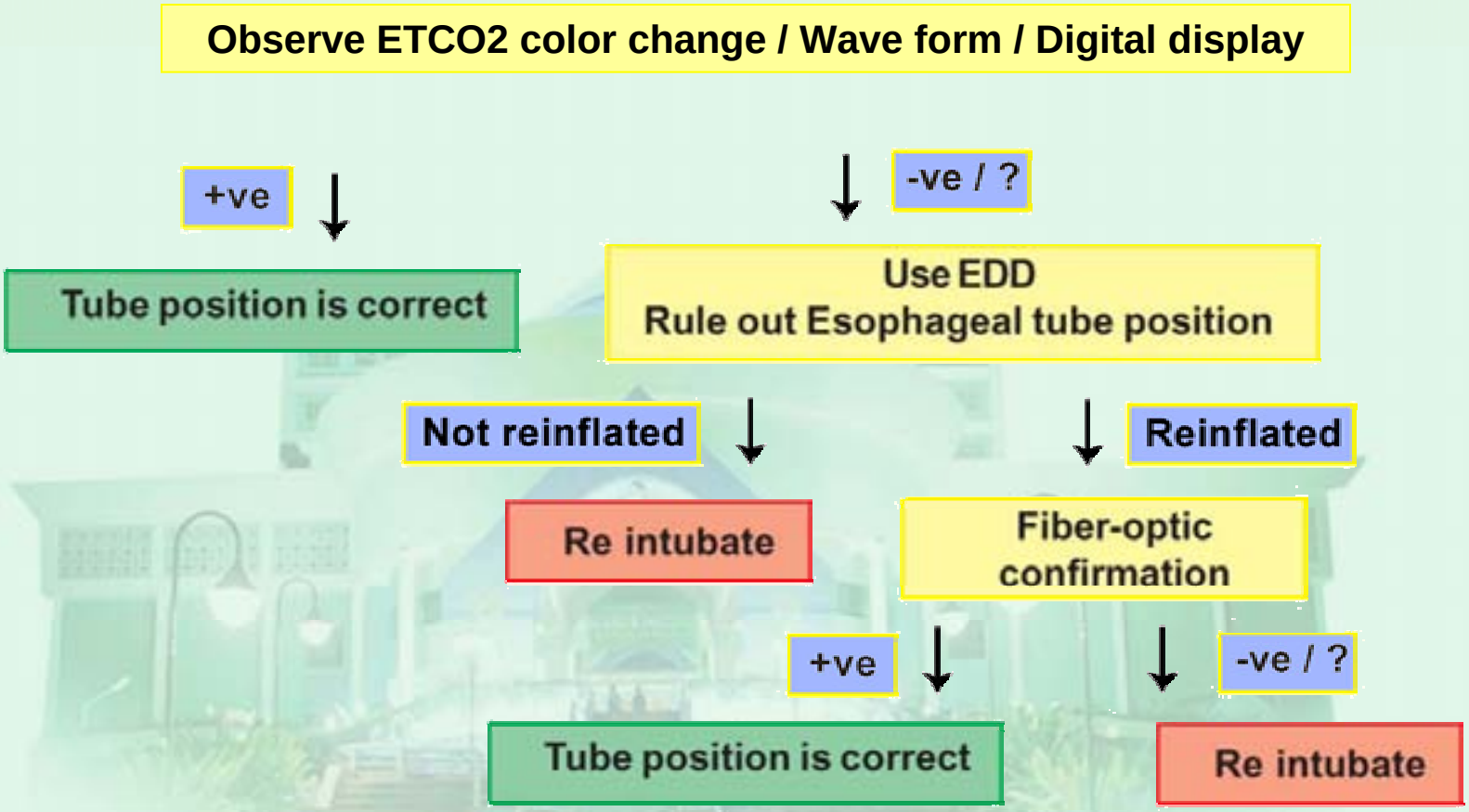
↓

Look for adequate chest expansion

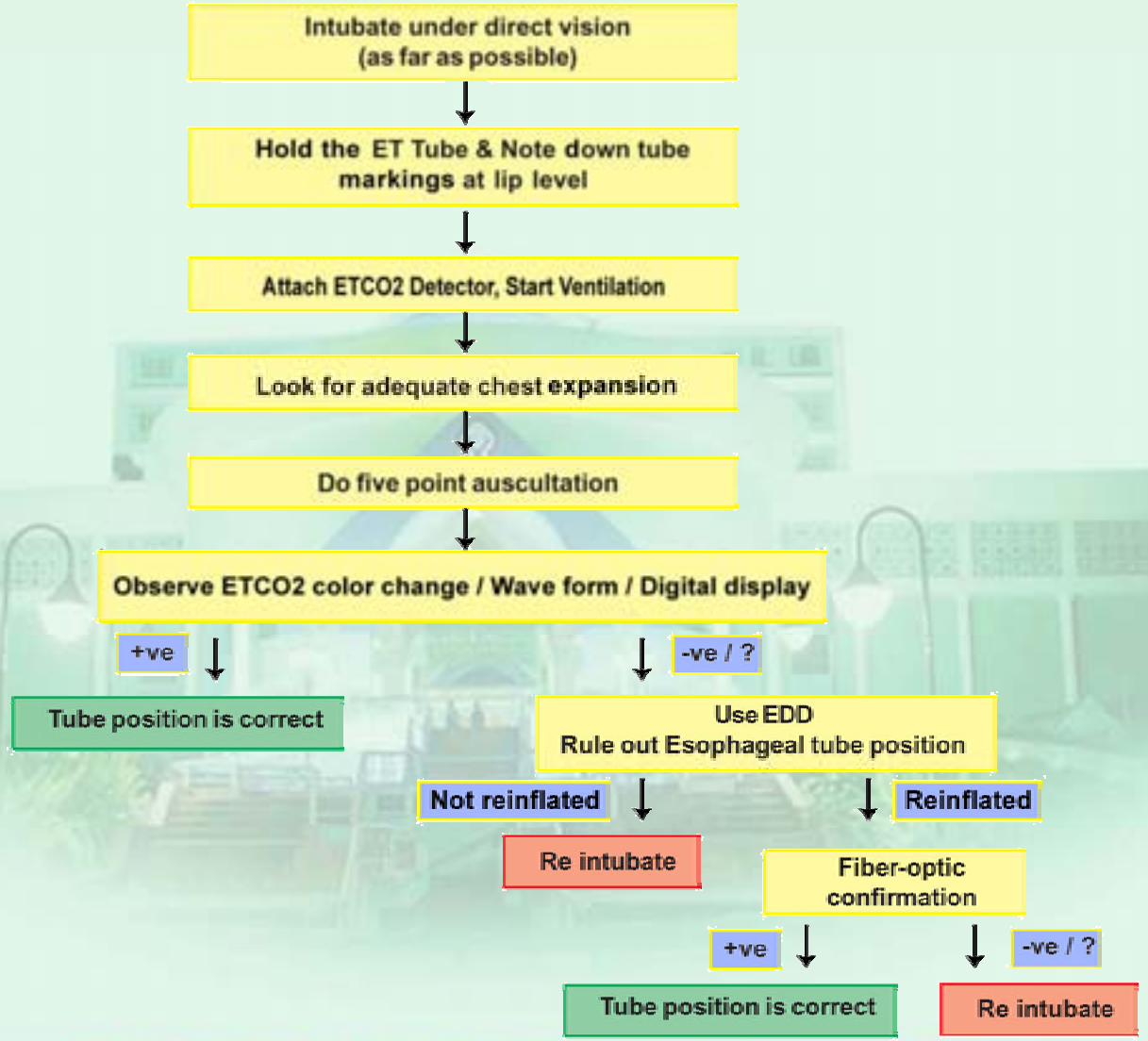
↓

Do five point auscultation

↓


Observe ETCO2 color change / Wave form / Digital display
+ve
Tube position is correct
-ve / ?
Use EDD
Rule out Esophageal tube position
Not reinflated
Re intubate
Reinflated
Fiber-optic confirmation
+ve
Tube position is correct
-ve / ?
Re intubate

Algorithm to confirm Tube Position



Conclusion

- Confirmation of proper tracheal tube placement is as important as successful intubation.
- Exhaled CO_2 detection is reliable and should be considered the standard for confirmation of tracheal placement of an ETT and for early detection of accidental esophageal intubation.

Conclusion

The Emergency Physician should make sure the availability of ET CO_2 detection devices in ER and with EMS team when they are in the field. They should also ensure usage of confirmation devices by the concerned persons

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