• **Trauma: Airway Management**

ASA Difficult Airway Algorithm Modified for Trauma — and Five Common Trauma Intubation Scenarios

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ontrary to popular opinion, trauma and emergency intubation situations can be aptly handled by following the ASA Difficult Airway (DA) Algorithm. To do so, however, requires that certain elements of the algorithm be de-emphasized (e.g., references to stopping airway management and coming back later).

This article summarizes the important concepts that have been developed over the last decade in management of the traumatized airway. Because airway management is the most important initial element in trauma management, and because anesthesiologists are typically providing this support, it is important that our specialty develop an organized approach to the general condition of the "trauma airway" as well as for several common trauma DA scenarios.

To this end, this article provides a brief history of the ASA DA Algorithm, followed by a survey of the current algorithm (published in *Anesthesiology* in May 2003), focusing upon the exceptions and emphasizing trauma. After this, five common trauma scenarios with airway considerations are explored with their condition specific algorithms. PETCO2 detection is recommended for confirming endotracheal tube (ETT) position when cardiac output is adequate. When cardiac output is inadequate to demonstrate exhaled CO2, the self-inflating bulb (SIB), also known as the esophageal detector device (EDD), should be used to confirm ETT position when the cardiac output is not adequate.

These algorithms represent years of refinement. Although they represent the current state of the art as of November 2005, they should still be considered works in progress. We are continuously looking for improved clarity of thought and improvements in patient safety during emergency trauma airway management.

Some material in this article was presented by William C. Wilson, M.D., University of California-San Diego Medical Center, and Mohammad I. El-Orbany, M.D., Ninos J. Joseph, B.S., and M. Ramez Salem, M.D., Department of Anesthesiology, Advocate Illinois Masonic Medical Center, Chicago, Illinois, as a Scientific Exhibit at the 2003 ASA Annual Meeting in San Francisco.

ASA Difficult Airway Algorithm Development

Practice guidelines for management of the DA were originally published in 1993 (*Anesthesiology*. 1993; 78:597-602) and were updated recently in a report published by the ASA Task Force on Management of the Difficult Airway in May 2003 (*Anesthesiology*. 2003; 98:1269-1277).

The original practice guidelines (1993) were published by a task force of ASA members who expounded upon the original ideas put forth in a "Medical Intelligence Article" in *Anesthesiology* written by Jonathan L. Benumof, M.D., in 1991 titled "Management of the Difficult Airway" (*Anesthesiology*. 1991; 75:1087-1110).

In 1996, Dr. Benumof wrote another landmark article discussing the development and use of the laryngeal mask airway (LMA) and its implications on the ASA DA Algorithm (*Anesthesiology*. 1996; 84:686-699). This article contributed to ASA's decision to revise the 1993 algorithm. The current (May 2003) version emerged after the ASA task force reviewed the literature published over the last 60 years and obtained expert opinions from other ASA members to build a consensus.

2003 Practice Guidelines Key Points

A. Airway history is useful (ask patient, check chart/bracelet).

B. Airway examination (11 Step) should be conducted on all patients whenever feasible.

Table 1: Eleven Step Airway Examination

Step	Airway Examination Component	Non-reassuring Findings
1	Length of upper Incisors	Relatively long
2	Maxillary–mandibular incisor relationship	Prominent “overbite”
3	Ability To prognanth jaw	Unable
4	Interincisor distance	< 3 cm
5	Visibility of uvula	Mallampati class III/IV
6	Shape of palate	Highly arched or narrow
7	Mandibular space compliance	Stiff, indurated, noncompliant
8	Thyromental distance	< 3 “normal finger” breadths
9	Length of neck	Short
10	Thickness of neck	Thick
11	ROM of head & neck Note: Cannot examine ROM in unstable C-spine patients! Assume incomplete ROM in C-spine (unless cleared)	Incomplete ROM.

C. Additional evaluation may be indicated in some patients (e.g., RA patients should have flexion/extension c-spine x-rays).

D. Basic preparation for a difficult airway, per 2003 ASA DA Guidelines requires a portable DA storage unit with contents that include airway tools that can assist management of the difficult airway. These are listed in Table 2.

E. When a patient is identified as having a DA several things should happen:

1. Inform patient / family of risks, plans, & alternate management methods

2. Identify an experienced helper to assist in managing the DA

3. Pre-oxygenate

4. Pursue opportunities to administer O2 to patient during DA management

Table 2: Suggested Contents of D.A. Portable Storage Unit

1	Rigid laryngoscope blades of alternate design and size from those routinely used; this may include a rigid fiberoptic laryngoscope.
2	Tracheal tubes of assorted sizes
3	Tracheal tube guides. Examples include (but are not limited to) semi rigid stylets, ventilating tube changer, light wands, and forceps designed to manipulate the distal portion of the ETT.
4	Laryngeal mask airways of assorted sizes; this may include the intubating laryngeal mask airway and the LMA Proseal™ *(LMA North America, Inc., San Diego, CA)*
5	Flexible fiberoptic intubation equipment
6	Retrograde intubation equipment

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7 7. At least one device suitable for emergency noninvasive airway ventilation. Examples include (but are not limited to) an esophageal-treacheal combitube *(Kendall-Sheridan Catheter Corp., Argyle, NY)*, a hollow jet ventilation stylet, and a transtracheal jet ventilator.

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8 Equipment for an emergency invasive airway (e.g., cricothyrotomy)

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9 An exhaled CO2 detector + Esophageal Detector Device (S.I.B.)*

The items listed in this table represent suggestions. The contents of the portable storage unit should be customized* to meet the specific needs, preferences, and skills of the practitioner and healthcare facility.

F. The anesthesiologist should have a strategy for DA management—one such strategy is following the ASA DA algorithm (See ASA DA algorithm -Modified For Trauma). Every DA strategy requires the following elements:

1. Assess the likelihood of any one of the 4 basic problems:

- Difficult Ventilation
- Difficult Intubation
- Difficulty with patient Cooperation or Consent
- Difficult Tracheostomy

2. Consider the merits of crossing the 3 basic bridges to airway access:

- Awake vs. general anesthesia (RSI +/- modified with PPV)
- Natural airway with endotracheal tube (ETT) vs. surgical airway
- Spontaneous ventilation vs. apnea

3. Identify the preferred primary approach (patient & condition specific).

4. Identify a back up approach (i.e., Plan “B”). See Table 3 for options.

Table 3: Techniques for Difficult Airway Management

Technique of Difficult Intubation	Techniques for Difficult Ventilation
Alternative laryngoscope blades	Esophageal-tracheal Combitube (ETC)
Awake intubation	Intratracheal jet stylet
Blind intubation (oral or nasal)	Laryngeal mask airway (LMA)
Fiberoptic intubation (FOB)	Oral & nasopharyngeal airways
Intubating stylet or tube changer	Rigid ventilating bronchoscope
LMA as an intubating conduit	Invasive airway access
Light wand	Transtracheal jet ventilation (TTJV)
Retrograde intubation	Two-person mask ventilation
Invasive “surgical airway” access (e.g. Cricothyroidotomy kit)	Invasive “surgical airway” access (e.g. Cricothyroidotomy kit)

This table displays commonly cited techniques. It is not a comprehensive list. The order of presentation does not imply preference for a given technique or sequence of use. Combinations of techniques may be employed. The techniques chosen by the practitioner in a particular case will depend upon specific needs, preferences, skills, and clinical constraints.

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5. Exhaled CO2 should be used for confirmation of tracheal intubation.

6. Consideration of conducting surgery with regional/local technique. (Significant judgment is required for determining which DA trauma patients can be safely managed using a regional technique. **Regional is seldom wise for acute trauma (Table 4)**.

Table 4: Use of Regional Anesthesia (R.A.) for Trauma Patients with Difficult Airways

GOOD IDEA	BAD IDEA	RATIONALE
Superficial extremity repair under R.A. -cooperative, HD stable, sober patient	Major head, chest, abd. surgery under R.A. - Pt with altered sensorium	Risk of deterioration from injuries, R.A. failure or complication
Can stop surgery anytime	Cannot stop surgery; Inc'd RA risks	Ability to start over with new plan
Good access to airway, have awake intubation agreement, no sedation	Poor access to airway, no awake intubation agreement, or Å´'d M.S.	Ability to do awake intubation in the middle of the operation

G. The anesthesiologist should also have a strategy for extubation or tube change of the DA patient. Every DA extubation strategy requires consideration of the following 4 elements:

1. Consider the relative merits of awake extubation (should be universally employed).
2. Evaluate the factors that may adversely impact ventilation after extubation
3. Formulate an airway management plan that can be implemented if the patient is not able to maintain adequate ventilation after extubation
4. Consider use of an airway exchange catheter (AEC) for short-term use. An AEC can serve as a guide for expedited reintubation, or (via the hollow inner core) as a method to provide O2 -by insufflation (if patient breathing spontaneously) - or via jet ventilation.

H. Follow-up care

1. Inform patient/family of difficulty. Suggest patient get a card in wallet and a bracelet stating difficult airway
2. Document in chart specific problems with mask ventilation, LMA ventilation & intubation. Also, document which tools were used successfully or unsuccessfully. Provide all guidance relevant for the next person managing the patient in the future.

2003 Difficult Airway Algorithm (click to enlarge)

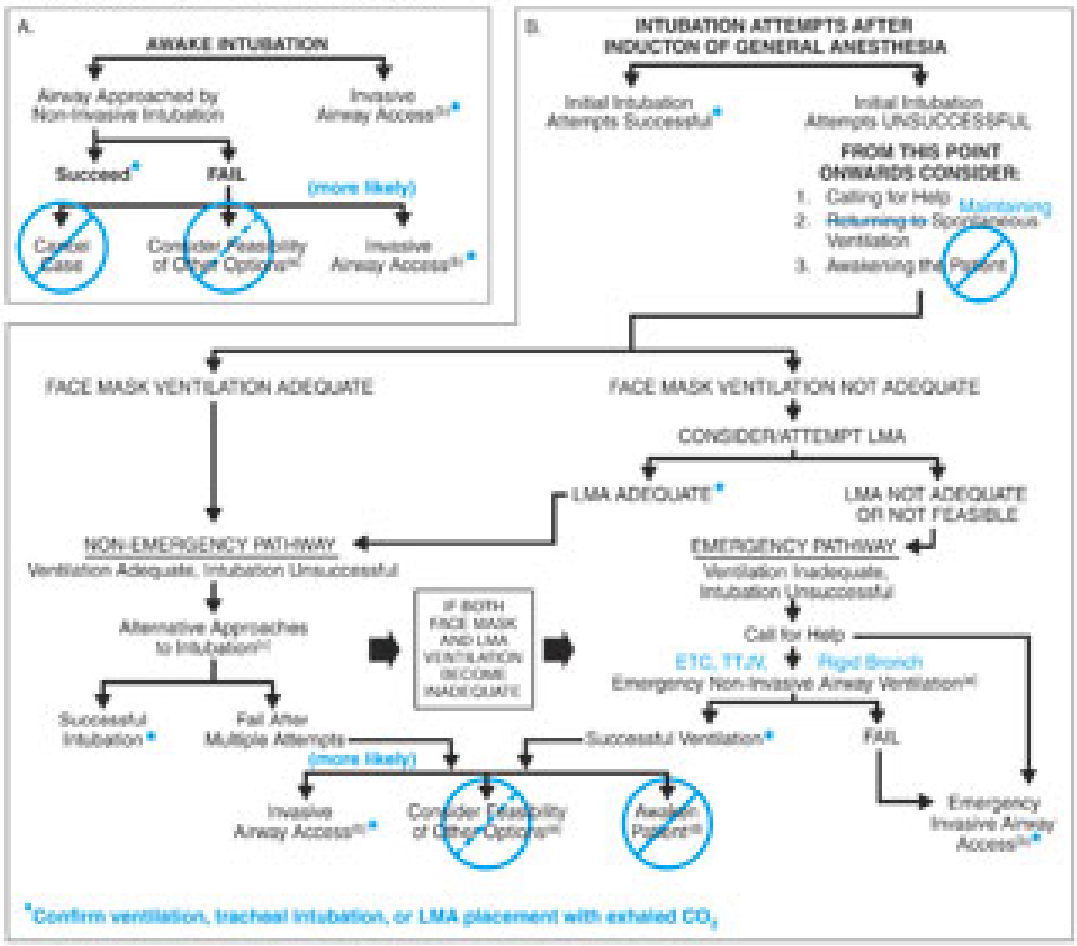
AMERICAN SOCIETY OF ANESTHESIOLOGISTS

2003 DIFFICULT AIRWAY ALGORITHM (MODIFIED FOR TRAUMA)

1. Assess the likelihood and clinical impact of basic management problems:
   - A. Difficult Ventilation
   - B. Difficult Intubation
   - C. Difficulty with Patient Cooperation or Consent
   - D. Difficult Tracheostomy
2. Actively pursue opportunities to deliver supplemental oxygen throughout the process of difficult airway management.
3. Consider the relative merits and feasibility of basic management choices:

A.	Awake Intubation	vs.	Intubation Attempts After Induction of General Anesthesia
B.	Non-Invasive Technique for Initial Approach to Intubation	vs.	Invasive Technique for Initial Approach to Intubation
C.	Preservation of Spontaneous Ventilation	vs.	Ablation of Spontaneous Ventilation

4. Develop primary and alternative strategies:



a. Other options include (but are not limited to): surgery utilizing face mask or LMA anesthesia, local anesthesia infiltration or regional nerve blockade. Pursuit of these options usually implies that mask ventilation will not be problematic. Therefore, these options may be of limited value if this step in the algorithm has been reached via the Emergency Pathway. Judgment required. Rarely appropriate for trauma patients.

b. Invasive airway access includes surgical or percutaneous tracheostomy or cricothyrotomy.

c. Alternative non-invasive approaches to difficult intubation include (but are not limited to): use of different laryngoscope blades, LMA as an intubation conduit (with or without fiberoptic guidance), fiberoptic intubation (FOB), intubation stylet or tube changer (airway exchange catheter, [AEC]) light wand, retrograde intubation, and blind oral or nasal intubat

d. Consider re-preparation of the patient for awake intubation or canceling surgery. Rarely applicable in the trauma patient.

e. Options for emergency non-invasive airway ventilation include (but are not limited to): rigid bronchoscope (Rigid Bronch), esophageal tracheal combitube ventilation (ETC), or transtracheal jet ventilation (T

f. Extubation strategies include: evaluation of the airway with FOB and extubation over an airway exchange catheter (AEC).

Modifications of the ASA DA Algorithm for Trauma (shown on above algorithm)

A. Stopping to come back another day is seldom an option with trauma.

B. A surgical airway may be the first/best choice in certain conditions.

C. An awake ETT technique should be chosen in a DA patient providing the patient is cooperative, stable, and spontaneously ventilating.

D. If the patient becomes uncooperative/combative general anesthesia (GA) may need to be administered — but if the airway is difficult, spontaneous ventilation (SV) should be continued (if possible).

E. Awake limb of the ASA Algorithm—Trauma Notes. An awake intubation technique is recommended for all trauma patients with a recognized difficult airway…. Providing the patient is cooperative, stable, and maintains spontaneous ventilation and adequacy of O2 saturation. The ASA DA Algorithm does not endorse any particular airway technique. However, it does emphasize that the patient must be properly prepared (mentally & physically) for an awake technique.

F. Anesthetized or uncooperative limb of ASA DA Algorithm — Trauma Notes. There are three common conditions when the need arises to intubate the trachea of an unconscious or anesthetized trauma patient with a DA:

1. Clinician fails to recognize a difficult airway in preoperative evaluation prior to the induction of anesthesia.
2. The DA patient is already unconscious prior to being assessed by the trauma anesthesiologist.
3. The patient obviously has a DA, but is hemodynamically unstable (e.g., following trauma) or absolutely refuses to cooperate with an awake intubation (e.g., child, mentally retarded, drugged, or head-injured adult).

Once the patient is anesthetized or is rendered apneic or presents comatose and the trachea cannot be intubated, O2, enriched mask ventilation (MV) is attempted.

If MV adequate, a number of intubation techniques may be employed. Techniques allowing continuous ventilation during airway manipulations are favored over those requiring an interruption of mask ventilation (e.g., FOB, via an LMA or an airway intubating mask, with self-sealing diaphragm).

Alternatively, techniques requiring a cessation of ventilation (at least temporarily) can be employed. These techniques are relatively contraindicated for patients with large right-to-left transpulmonary shunt, or decreased FRC.

G. Confirmation of endotracheal tube (ETT) position. Immediately after the patient's trachea is intubated, one must confirm ETT position with end-tidal CO2 measurement. If end-tidal CO2 measurement is unavailable, Wee's esophageal detector device (EDD) is reasonably reliable (close to 100% sensitive and specific).

H. Extubation or ETT change of the DA. If the conditions that caused the airway to be difficult to intubate still exist at the time of extubation, or if new DA conditions exist (e.g., airway edema, halo), then the trachea should be extubated over an AEC and or with the assistance of a FOB.

ASA DA Algorithm Applied to Specific Trauma Conditions

Closed-Head Injury/Intoxication
CLOSED HEAD INJURY / INTOXICATION
At left: CT of brain demonstrating severe closed- head injury with right temporoparital subdural hematoma.

General Considerations
If DA, do an awake intubation, provided the patient is cooperative, stable, maintains SV and **has a GCS > 9.**

Key Questions:

How severe?

• GCS ≤ 9 = RSI (± modified, i.e., cricoid pressure, ± PPV)
• GCS > 9 = Awake option

Cooperative?

If yes, do awake technique.

Key Management Points:

A. Keep CPP > 70
B. Avoid hypoxia
C. Expedite airway management *(may need to temporarily hyperventilate)*

Closed Head Injury Algorithm (click to enlarge)

Cervical Spine injury
CERVICAL SPINE INJURY
A. Lateral C-spine X-ray showing C5-6 bifacet dislocation.
B. Lateral C-spine X-ray showing atlanto-occipital dislocation.

General Considerations
If DA, do an awake intubation, provided the patient is cooperative, stable, maintains SV, **especially if the patient has neurological symptoms from spinal cord injury (SCI).**

Key Questions:

Does the rest of the airway examination (HMD < 6 cm, Mallampati Class IV, small mouth) predict a DA??

If yes, do awake.

Does the patient have a neurological deficit?

If yes, do awake technique.

Key Management Points:

A. Maintain In-line immobilization.
B. For RSI, maintain cricoid pressure with one hand supporting neck from behind.

Cervical Spine Injury Algorithm

* The awake FOB technique is = rigid direct laryngoscopy/GA providing no neck movement.

Airway Disruption
Airway Disruption
Left: Site-specific frequencies of blunt traumatic airway injuries. Bottom: Biomechanics of blunt trauma to the major airways.

General Considerations
Do an awake intubation, provided the patient is cooperative, stable, maintains SV, **especially for major laryngeal/ tracheal tears.**

Key Questions:

Major laryngeal/tracheal tears?

If so, do awake technique.

Small lesions? Or supralaryngeal?

If so, RSI (± modified).

Key Management Points:

A. Maintain SV even with modified RSI technique.
B. Get ETT below tear.
C. Do not pressurize airway proximal to tear.
D. No TTJV, LMA, etc.
E. Consider DLT, Consider CPB.

Airway Disruption Algorithm

Airway Compression
Airway Compression
Traumatic injury to face, maxilla and mandible. (Image courtesy of Pablo Pratesi, Hospital Universitario Austral, Argentina.)

General Considerations
A. Do awake ETT, provided the patient is cooperative, stable, maintains SV and O2 saturation and is able to clear airway of blood, foreign bodies, secretions and maintain patency.

B. MV may be difficult even if ETT is easy.

C. Blind nasal technique is contraindicated if: CSF leak, Le Fort or basal skull fracture.

D. Initial decision-making based upon A.B.C.s; later, must be practical with the need for future jaw wiring.

Key Questions:

Life-threatening obstruction?

If yes, surgical airway.

Not life-threatening (i.e., able to clear airway)?

Then consider DA issues as well as need for jaw wiring.

Maxillary-Facial Trauma Algorithm

N.B. May need to convert from oral to nasal or trach later (for jaw wiring considerations).

Airway Compression
Airway Compression
Lateral C-spine X-ray (top) and CT scan (bottom) showing massive retropharyngeal hematoma

General Considerations
Do awake intubation, provided the patient is cooperative, stable, maintains SV, not life-threatening and able to maintain patency.

Key Questions:

Life-threatening obstruction?

If so, surgical airway.

Not life-threatening?

If not, FOB a good choice as long as able to see entire way.

Key Management Points:

A. Maintain SV even when with GA (modified RSI).
B. Get ETT below obstruction.
C. No supraglottic solutions (LMA, ETC, etc.).
D. If using TTJV, may need help with exhalation. Consider opening wound if strider due to postoperative expanding neck hematoma.

Airway Compression Algorithm

VERIFICATION OF ETT POSITION

A. VERIFICATION OF ETT POSITION FOLLOWING & INSERTION
Direct ETT position verification is best (see ETT in trachea, see tracheal rings with FOB, see ETT going through cords with rigid direct laryngoscopy. Indirect methods are more error prone. However, PETCO2 and the SIB (or the EDD) are the best indirect methods for verification of ETT position.

General Considerations
Do awake intubation, provided the patient is cooperative, stable, maintains SV, not life-threatening and able to maintain patency.

A. In E.R. & I.C.U. settings, a CXR reveals mal-positioning of ETT.
B. Other techniques (FOB, cuff ballottement, etc.) can decrease CXR use

Notes on PETCO2 During Resus.
Do awake intubation, provided the patient is cooperative, stable, maintains SV, not life-threatening and able to maintain patency.

During Circ. arrest, CO2 monitoring can be unreliable despite ETT position. In these patients, devices such as the SIB or the EDD are more helpful.

However, during C.P.R., monitoring CO2 provides a prognostic indicator of resuscitation efficacy.

B. VERIFICATION OF ETT POSITION IN ICU PATIENTS (Electively)
Previously placed ETTs can migrate, and become disloged. Accordingly their correct positioning should be verified from time to time. Additionally, circumstances arise where more urgent re-evaluation of ETT position is waranted (e.g. cuff leak).

ETT Should Be Verified periodically & following:

1. Changes in tube position
2. Changes in head, neck, or body position
3. suspected decrease in FRC (e.g. Abd. Dist.)
4. Traction on the trachea or esophagus
5. Unexpected fall in SaO2
6. Biphasic CO2 waveform
7. Unexpected cuff leak

Cuff leak after adequate cuff inflation can be due to:

1. Cuff protruding above cords
2. ETT (& cuff) too small
3. Extremely compliant airway (e.g.Tracheomalacia)
4. T-E fistula (very rare)
5. Defective /damaged cuff
6. Defective pilot-balloon
7. Kinking of connecting

ETT CHANGE IN I.C.U. PATIENTS WITH DIFFICULT AIRWAYS
"Generally a hazardous intervention when conducted in critically ill patients"

General Points To Consider Prior To Changing ETT:

1. Determine urgency & necessity for ETT change
2. Have necessary equipment & assistance available
3. Have a back-up plan "B", prepared & available (esp. if D.A.)
4. Try simple maneuvers that obviate need for ETT Change
5. Provide O2, and use oximetry & capnography monitoring
6. Prepare pt. (topical anesthesia, antisialogogue, sedation)
7. Changing Nasal-> Oral, Oral -> Nasal, more complicated

Algo. Specific Points:

1) Determine route of the ETT replacement (oral vs. nasal)
2) Regardless if using FOB, or RDL,… an A.E.C. should be considered – as a back up safety tool (see specific comments below)
3) Maintain SV whenever able

Specific Remarks about R.D.L., F.O.B. and A.E.C. during ETT changes in Critically Ill patients are provided on below.

A. Use of Rigid Direct Laryngoscopy (RDL)
Rigid Direct Laryngoscopy is the most common method of tube exchange – but, is only appropriate when clinical indicators suggests easy laryngoscopy, and lack of airway swelling

Technique:

1. Preoxygenation, sedation and neuromuscular blockade (if appropriate)

2. Suction oropharynx (consider placing A.E.C. – see below)

3. Perform direct laryngoscopy exposing glottis end entry of existing tube

4. Place new tube in close proximity to old ETT, Deflate cuff of existing ETT

5. Instruct assistant to slowly withdraw existing ETT, immediately insert the new one

6. Confirm ETT position using capnography and clinical signs.

B. Use of the Flexible Fiberoptic Bronchoscope

Use flexible fiberoptic bronchoscope (FOB) to exchange ETT, nasal to nasal, nasal to oral, oral to oral and oral to nasal.

Technique:

1. Preoxygenation, sedation, antisialogogue, topical anesthesia & mucosal vasoconstriction (if nasal)

2. Suction oropharynx and nasopharynx (as appropriate)

3. Preload the FOB with desired ETT, preferably with bronchoscopic adapter attached.

4. Thoroughly lubricate the FOB and the ETT

5A. IF new tube to be oral - Pass the scope orally (± oral intubating airway), advance FOB through the larynx (anterior to the existing ETT)

5B. IF new tube to be Nasal - Pass the scope nasally, advance FOB through the larynx (anterior to the existing ETT)

6. Deflate the cuff and maneuver the FOB beyond it to just above the carina

7. Have an assistant slowly withdraw the preexisting tube

8. Thread the ETT over the FOB as soon the old ETT is above the larynx

9. If problems are encountered in threading the new ETT over the FOB, be sure the FOB is straight, and twist the ETT 180 degrees as the ETT is threaded into the airway.

10. Ventilate through the adapter once the replacement ETT is in or withdraw the FOB and start ventilation.

C. Use of Hollow Tube Airway Exchange Catheters (A.E.C.s)

(Involves verification of in *situ* ETT position with PETCO2 or self-inflating bulb (SIB)

Technique:

1. An appropriate sized hollow A.E.C. fitted with a 15 mm airway adapter is prepared

2. The position of the in situ ETT is verified by PETCO2 or the SIB

3. The catheter is advanced beyond the distal tip of the in situ tube

4. The position of the hollow catheter is verified by PETCO2 or the SIB & the 15 mm airway adapter is removed.

5. The existing ETT is withdrawn after cuff deflation (and suctioning) while the catheter is firmly held in place by assistant.

6. The new lubricated ETT (fitted with a FOB / A.E.C. adapter with a self-sealing diaphragm) is threaded over the catheter and positioned in place.

7. The position of the new ETT is verified using PETCO2 or the SIB connected to the side arm of the adapter while occluding the catheter proximally.

8. The catheter is finally withdrawn

9. Further confirmation of tube position can be obtained with a F.O.B.