BRONCHOSCOPY IN THE [ ADULT ] INTENSIVE CARE UNIT

G. Domenighetti, PD
1 PATHOPHYSIOLOGICAL CONSEQUENCES OF FFB IN THE INTUBATED PATIENT

2 SPECIFIC INDICATIONS OF FFB IN THE ICU-PATIENT

3 CONTRAINDICATIONS AND COMPLICATIONS OF FFB

4 RECOMMENDATIONS FOR THE FFB PROCEDURE IN THE [INTUBATED] PATIENT
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EFFECTS OF FOB ON RESPIRATORY MECHANICS: how perform pressures and volumes?

FOB E.D. : 5.9 mm

DELIVERED Vt AT DIFFERENT ET SIZES, DIFFERENT RR, FLOWS AND COMPLIANCE, IN A VOLUME-GUARANTEED MODE OF VENTILATION. BASELINE Vt WAS SET AT 700 ml

HIGH PEEP\textsubscript{IN} LEVELS WERE RECORDED

DELIVERED Vt AT DIFFERENT ET SIZES, AT DIFFERENT RR AND COMPLIANCE, IN A PRESSURE - CONTROLLED MODE OF VENTILATION. BASELINE Vt WAS SET AT 700 ml

FROM THIS BENCH STUDY, THE AUTHORS CONCLUDE THAT:

- EXTREMELY LOW VT AND HIGH AUTO-PEEP LEVELS MAY DEVELOP UNLESS RESPIRATORY RATE, ETT SIZE, MODE AND FLOW ARE CAREFULLY SELECTED.

- AN HIGH FLOW [ 80 L/min ] ASSOCIATED WITH A RESPIRATORY RATE OF 12 cycles/min AND A SQUARE FLOW WAVEFORM ARE ASSOCIATED WITH A REDUCED AUTO-PEEP.

- THE PRESSURE - CONTROLLED MODE, DELIVERS MORE VT THAN THE VOLUME - CONTROLLED MODE.

- TO ENSURE AN APPROPRIATE VT, THE INSIDE DIAMETER OF THE ETT SHOULD BE ≥ 2.0 mm LARGER THAN THE OUTSIDE DIAMETER OF THE BRONCHOSCOPE.

• PEAK INFLATION PRESSURES MAY REACH VERY HIGH VALUES [80-90 cm H₂O]

• THESE RECORDED PRESSURES REPRESENT VENTILATOR BACK PRESSURES WHILE INTRATRACHEAL MEASURED PRESSURES ARE MUCH LOWER [< 20 cm H₂O]; RARELY, AVERAGE PRESSURES OF 34 cm H₂O HAVE BEEN RECORDED INTRATRACHEALLY

• THE INTRATRACHEALLY RECORDED PRESSURES REMAIN POSITIVE AT END-EXPIRATION, IN AVERAGE BETWEEN 10 AND 15 cm H₂O, BUT VALUES UP TO 35 cm H₂O HAVE BEEN REPORTED.

• WHEN SUCTION IS APPLIED, PEEP IS REDUCED OR MAY DISAPPEAR

• ALL THESE PRESSURE CHANGES ARE CLOSELY LINKED TO THE INTERNAL DIAMETER OF THE ETI
A: 5 mm ED  
B: 5.7 mm ED  
C: 6.4 mm ED  

**good ratio**

**good ratio for an effective airway secretions removal**

EFFECTS OF FOB ON GAS EXCHANGE

THE PRESENCE OF THE BRONCHOSCOPE IN THE AIRWAYS INDUCES:

• A DECREASE IN THE PaO2
• AN INCREASE IN THE PaCO2


THESE ALTERATIONS ARE MAGNIFIED DURING SUCTIONING, WHERE AS MUCH AS 200 TO 300 ml OF THE PATIENT’S VT CAN BE REMOVED!

GAS EXCHANGE MODIFICATIONS: SUGGESTED MECHANISMS

• REDUCTION OF EXPIRED Vt, PREDOMINANTLY DURING SUCTION
• REDUCTION OF AUTO-PEEP DURING SUCTION
• REFLEX BRONCHOSPASM
• REDUCTION OF THE EXCHANGE AREA DURING BAL
• RELEASE OF INFLAMMATORY MEDIATORS DURING BAL

• SOMETIME, IMPROVEMENTS IN OXYGENATION MAY BE OBSERVED
  [CLEARANCE OF SECRETIONS; RECRUITMENT OF COLLAPSED AREAS BY AUTO-PEEP]
EFFECTS OF FOB ON HAEMODYNAMICS

Lindholm C et al. Chest
1978, 74: 362-367

Trouillet J-L et al. Chest
1990; 97: 927-933
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INDICATIONS FOR BRONCHOSCOPY IN THE ICU

**PRIMARILY DIAGNOSTIC:**

- Ventilator-associated pneumonia [ VAP ] and pneumonia in the immunocompromised host [ BAL; PSB; TBB ]
- Respiratory failure due to non-infectious lung disease
- Localized wheeze or stridor in the non-intubated patient
- Airway trauma [ blunt thoracic, intubation, post-op. injury ]
- Acute inhalation injury or burns
- Verification of proper ET or double-lumen ET tube placement
- Verification of suspected larynx oedema in the intubated patient

**PRIMARILY THERAPEUTIC:**

- Airway management [ ET & double-lumen ETT placement & change]
- Atelectasis and excess airway secretions
- Haemoptysis
- Foreign bodies
- Fibrin glue therapy [ bronchopleural fistulae ]
Infections nosocomiales aux soins intensifs

Prévalence 27% (9.7%-31.6%)

- Pneumonies 47%
- Cicatrices post-op 7%
- Autres NI 16%
- Infections du sang 12%
- Infections urinaires 18%

Etude EPIC (28.04.1992)
17 pays européens
1’417 unités soins intensifs
10’038 patients

Vincent J-L et al. JAMA 1995

courtesy of Ph. Eggimann, MD
BRONCHOSCOPY AND VENTILATOR-ASSOCIATED PNEUMONIA

H.A. 78 Y, PSEUDOMONAS PNEUMONIA AND SEPSIS

DAY 1

DAY 9

MRSA VA-PNEUMONIA [diagnosis corroborated through BAL]
WHICH BRONCHOSCOPIC TECHNIQUE SHOULD WE USE TO OBTAIN BACTERIOLOGICAL SAMPLES IN (INTUBATED) PTS WITH SUPPOSED ( V-A ) PNEUMONIA?

PREAMBLE 1: THE DIAGNOSIS OF BACTERIAL PNEUMONIA IN THE SEVERELY ILL, MECHANICALLY VENTILATED PATIENT REMAINS A DIFFICULT DILEMMA

PREAMBLE 2: TWO OF THREE COMPONENTS USED FOR A VAP DIAGNOSIS ARE NON-SPECIFIC [ SYSTEMIC SIGNS OF INFECTION; NEW OR WORSENING INFILTRATES ] THEREFORE, WE NEED THE BACTERIOLOGICAL EVIDENCE


• FFB HAS AN HIGH DIAGNOSTIC YIELD IN IMMUNOCOMPROMISED PATIENTS WITH PULMONARY INFILTRATES; PSB HAS A LOWER DIAGNOSTIC YIELD THAN THAT OF BAL; BAL COMBINED WITH TBB HAVE THE HIGHEST DIAGNOSTIC YIELD (Jain P et al. Chest 2004; 125: 712-722)
• BLIND SAMPLING OF LOWER RESPIRATORY TRACT SECRETIONS [ ASPIRATION OR mini-BAL USING VARIOUS DEVICES ] HAVE COMPARED FAVOURABLY WITH BRONCHOSCOPE-GUIDED METHODS IN TRIALS ON CRITICALLY ILL PATIENTS

BRONCHOSCOPY AND RESPIRATORY FAILURE DUE TO NON-INFECTIONOUS DISEASES OR “NON-CONVENTIONAL” INFECTIOUS DISEASES IN NON-IMMUNOCOMPROMISED PATIENTS

1. THE BAL-FLUID ANALYSIS AND THE BAL WHITE CELL DIFFERENTIAL MAY HELP TO DISTINGUISH CONDITIONS THAT MIMIC AND / OR CAUSE ARDS. SOME OF THEM ARE TREATABLE.

2. THE BAL FLUID CELL PROFILE MAY GIVE PROGNOSTIC INFORMATION IN ARDS PATIENTS.  
   ( Steinberg KP et al. Am J Respir Crit Care Med 1994; 150: 113-122 )

3. THE FIBROPROLIFERATIVE ARDS PHASE MAY BE AMENABLE TO A CORTICOSTEROID TREATMENT  
   ( Meduri U et al. JAMA 1998; 280: 159-165 )

4. THE BAL FLUID AND CELL ANALYSIS ARE CURRENTLY A POTENT RESEARCH TOOLS IN THE FIELD OF THE ACUTE LUNG INJURY  
   [ inflammatory mediators, alveolar fluid transport, proteomics, etc ]
# SOME CONDITIONS THAT MAY MIMIC AND/OR CAUSE THE ACUTE RESPIRATORY DISTRESS SYNDROME

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>SPECIFIC TREATMENT</th>
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### PNEUMONIAS
- Miliary Tuberculosis: YES
- CMV: YES
- Pneumocystis Carinii: YES
- Fungal: YES

### CRYPTOGENIC CAUSES
- Acute Interstitial Pneumonia: YES
- COP/BOOP: YES
- Acute Eosinophilic Pneumonia: YES
- Amiodarone-Induced ALI: [YES]

### MALIGNANCY
- Bronchoalveolar Cell Carcinoma
- Lymphangitis
- Acute Leukaemia: YES
- Lung Lymphoma: YES

### OTHERS
ACUTE INHALATION INJURY OR BURNS

Case report: accidental anhydrous ammonia inhalation exposure [from an old broken freezer serpentine].

desquamation of the mucosal epithelial layer
VERIFICATION OF PROPER ET OR DOUBLE-LUMEN ET TUBE PLACEMENT

r. WHITE

l. CARLEN

modified broncho-cath

3.1 mm ED diameter

suited for insertion and position confirmation of double-lumen endobronchial tubes
36 y o male with mainly unilateral pneumoc. pneumonia and differential ventilation
VERIFICATION OF SUSPECTED LARYNX OEDEMA IN THE INTUBATED PATIENT

Post-extubation stridor in intensive care unit patients
Risk factors evaluation and importance of the cuff-leak test

A deflated cuff-leak exp. volume of <12% [ of cuff inflated Vt exp ] prior to extubation, is useful in identifying patients at risk for post - extubation stridor

n= 112
tube diameter: 8 mm
HAEMOPTYSIS : CAUSES

Neoplasm:
1) bronchial carcinoma, adenoma
2) metastatic lung cancer

Bronchiectasis

Infections:
1) mycobacteria, especially tuberculosis
2) fungal infections
3) lung abscess, necrotizing pneumonia
4) paragonimiasis
5) hydatid cyst

Vascular:
1) pulmonary infarct, embolism
2) mitral stenosis
3) iatrogenic rupture of pulmonary artery by balloon-tipped catheter
4) broncho-arterial fistula
5) ruptured thoracic aneurysm
6) arteriovenous malformation

Vasculitis:
1) Behcet’s disease
2) Wegener’s granulomatosis

Miscellaneous:
anticoagulant therapy, coagulopathies (von Willebrand’s disease, hemophilia, thrombocytopenia), Goodpasture’s syndrome, trauma, lymphangioleiomyomatosis
MANAGEMENT OF HAEMOPTYSIS WITH FFB

- epinephrine instillation
- balloon tamponade [Swan; Fogarty]
- spraying of fibrin precursors

endobronchial hemostasis

- bronchial artery embolization
- surgery
FIBRIN GLUE THERAPY OF A BRONCHOPLEURAL FISTULA

A 75 year old man with a localized right infero-posterior emphyema and a broncho-pleural fistula after a right lower lobe resection for bronchogenic carcinoma.
"pathologic bubbles" after saline administration
Tissucol fibrin sealant
ATELECTASIS AND EXCESS AIRWAY SECRETIONS

Acute lobar atelectasis: a prospective comparison of fiberoptic bronchoscopy and respiratory therapy.


Conclusions:
In this group of 31 randomly allocated patients, fiberoptic bronchoscopy does not added to respiratory therapy in the treatment of acute lobar atelectasis. An air bronchogram predicted delayed resolution of collapse after bronchoscopy.
The overall success rate varies from 19 to 89% depending on the patient characteristics. Patients with lobar atelectasis respond better than those with more peripheral retained secretions. Chest therapy is effective in treating atelectasis approximately to the same degree as observed with the bronchoscope. Studies combining bronchoscopy with recruitment maneuvers in ventilated ICU-patients are warranted.
INDICATIONS FOR F.O. BRONCHOSCOPY IN ICU-PATIENTS WITH ATELECTASIS

1. LIFE-THREATENING ACUTE WHOLE LUNG OR NEAR WHOLE LUNG ATELECTASIS

2. LOBAR ATELECTASIS WITH A RADIOLOGICAL FINDING OF A BRONCHOGRAHM EXTENDING TO THE SEGMENTAL BRONCHI

3. ATELECTASIS FAILING TO IMPROVE WITH POSITIONING AND SUCTIONING AND/OR CHEST PHYSIOTHERAPY

4. NEUROMUSCULAR DISEASE WITH PROXIMAL ATELECTASIS SECONDARY TO INEFFECTIVE CLEARANCE AND MUCOUS PLUGGING

5. ATELECTASIS AND NOT FEASIBLE POSITIONING OR CHEST PHYSIOTHERAPY

6. CYSTIC FIBROSIS
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CONTRAINDICATIONS

• Inexperienced bronchoscopist for critically ill (intubated) ICU-patients
• Inability to adequately oxygenate and ventilate the patient
• Acute MI / Unstable coronary heart disease
• Worsening asthma
• Severe pulmonary hypertension
• Severe C-V instability
• Uncooperative patients
• .......

COMPLICATIONS IN THE ICU


• Hypoxemia
• Arrhythmias
• Related to premedication, topical anesthesia and sedation
• Fever and pneumonia
• Hemorrhage
• PNX
• .............
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SpO2: 88% with FiO2 = 0.9, PEEP 15 cm H2O, NO 10 ppm
PROCEDURE [ grading of recommendations. Thorax 2001;56(suppl I) i1-i21; other articles; personal experience ]

- USE THE RACOMMANDATIONS OF THE INFECTION CONTROL UNIT [C]
- GIVE ADEQUATE A.B. PROPHYLAXIS IF THE PATIENT NEEDS IT [C]
- REMOVE THE STOMACH CONTENT [B]
- GIVE A BRONCHODILATOR IN COPD AND ASTHMATIC PATIENTS [B]
- CHECK FOR THE INTRAVENOUS & ARTERIAL ACCESS EFFICIENCY
- DISCUSS WITH TEAM THE BEST SEDATION FOR A GIVEN PATIENT [B]
- CHECK ABG 10' BEFORE [AND 10' (+ 30’) ] AFTER THE PROCEDURE
- PATIENT IS MONITORED FOR HR, BP, SpO2 and PetCO2 [B]

THE ETT IS AT LEAST SIZE 8, OR: THE INSIDE DIAMETER OF THE ETT IS $\geq 2.0$ mm LARGER THAN THE OUTSIDE DIAMETER OF THE BRONCHOSCOPE [B]
• DO NOT USE A TOO LONG *ETT*

• USE A SWIVEL ADAPTER WITH A GOOD FITTED RUBBER CAP

• INCREASE FiO2 TO 1 BEFORE, DURING AND 30-60’ AFTER THE PROC.[B]

• SET THE VENTILATOR IN ORDER TO OBTAIN AN ADEQUATE Vț, VE ,SpO2

• PEEP IS DISCONTINUED OR REDUCED [B]

• USE SHORT SUCTION PERIODS

• STOP THE PROCEDURE IF VITAL SIGNS DETERIORATE. THE PROCEDURE MAY BE REINSTITUTED AFTER RETURNING OF STABLE VITAL SIGNS

• CHECK POSITION OF *ETT* AT THE END OF THE PROCEDURE

• COMPLETE THE PROCEDURE WITH A CHEST X-RAY
NIPSV + FFB: Procedure

In patients with a PaO2/FiO2 < 100
- SA = Seal Adapter
- FM = Facial Mask
- ES = Elastic Straps
- FOB = Bronchoscope


Courtesy of G. Conti, MD