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BRONCHOALVEOLAR LAVAGE

General indications:

- Non-resolving pneumonia
- Diffuse lung infiltrates (interstitial and/or alveolar)
- Suspected alveolar hemorrhage
- Quantitative cultures for ventilator associated pneumonia
- Infiltrates in an immunocompromised host
- Exclusion of diagnosable conditions by BAL, usually infection
- Research

BAL can be diagnostic in the appropriate clinical setting for:

- Alveolar hemorrhage
- Malignancies
  - Lymphangitic carcinomatosis
  - Bronchoalveolar carcinoma
  - Other malignancies
- Infections
  - PCP
  - Mycobacterial
  - Bacterial
  - Fungal
  - Viral

Equipment

- Flexible bronchoscope
- Sterile collection trap
- Suction tubing
- Sterile saline
- Vacuum source
- Syringe
- Optional 3 way stop-cock
- Lidocaine 1-2%

Preparation and Anesthesia

1. Obtain informed consent.
2. If an outpatient procedure, the patient should be accompanied by a person designated to drive the patient.
3. BAL should be planned to be performed prior to any other bronchoscopic procedure.
4. Review radiographs to determine ideal site of alveolar lavage.
   - In diffuse infiltrates, the right middle lobe (RML) or the lingula in the supine patient is preferred.
5. Prepare bronchoscope, collection trap, and tubing. (Click for image)
6. Prepare supplemental oxygen and monitoring equipment.
   - ECG, pulse-oximetry, BP cuff.
7. Premedicate with bronchodilators and/or warm the saline solution for those at risk for bronchospasm.
8. Position patient, preferably in supine position when approaching RML or lingula.
9. Apply monitors and supplemental oxygen.
10. Sedation with a benzodiazepine and a narcotic will allow patient comfort and minimize cough reflex.
    - Example: midazolam (adult dose 1 to 2.5 mg IV) and fentanyl (adult dose 25-100 mcg IV).
    - Topical anesthesia with lidocaine should be minimized.
      - Up to 8.2 mg/kg was found to be safe in a single study (endorsed as the maximum safe limit by the British Thoracic Society), but this amount is rarely necessary.
      - Conventional proposed maximum limits vary from 4-5 mg/kg. At our institution, we generally use the limit of 5 mg/kg of 2% lidocaine. Reduced limits are advised in those with liver or cardiac disease.

Technique

1. Perform preparatory steps and obtain adequate sedation. (See Preparation and Anesthesia)
2. Plan to perform the BAL preceding any other planned bronchoscopic procedure to avoid specimen contamination.

Critical Care

- Clinical Education
- Critical Care Cases
- Ethics
- Links
- Journal Club
- Information for Patients
- Podcasts
- Procedures
- Research
- Salvage Therapies for H1N1-induced ARDS
- Statements & Guidelines

- Avoid suctioning prior to obtaining BAL specimen.
- If needed however, the suction channel should be thoroughly rinsed with saline prior to the BAL.

3. Minimize use of topical anesthesia as there may be bacteriostatic effects of lidocaine.
    - Typically, we use the minimum amount of 2% lidocaine topically that is necessary to minimize coughing with a typical upper limit of 4-5 mg/kg.
4. Advance bronchoscope until wedged in a desired subsegmental bronchus at the desired location.
    - Avoidance of bronchial trauma is particularly important in the patient with suspected alveolar hemorrhage.
5. Infuse 20mL of saline with a syringe, observing the flow of saline at the distal tip of the bronchoscope.
6. Maintaining wedge position, apply gentle suction (50-80mmHg), collecting the lavage specimen in the collection trap.
7. Repeat steps 5 and 6, up to 5 times as needed (total 100-120 mL), to obtain an adequate specimen (40-60 mL - usually 40-70% recovery of total instillate).
    - Observe for flow of bubbles returning from the alveolar space.
    - Gentle re-orientation of bronchoscope tip may allow better return of fluid.
    - Distal airways may collapse at higher negative suction pressures.
    - Reduction in pressure or intermittent suctioning may help with distal airway collapse.
    - Instructing the patient to inhale and exhale deeply may also help improve return of specimen.
    - Higher aliquots and higher total volume can occasionally be used (up to 300 mL).
8. BAL specimen should be processed as soon as possible with desired tests ordered.
9. Patient should be observed for a minimum of 1 hour after the procedure, with continued monitoring.

Common tests/Analysis

Gross observation

- Pulmonary alveolar proteinosis
    - Opaque or translucent brownish or sandy colored fluid, sediments out into two layers if left to sit
- Alveolar hemorrhage
    - Sequentially more hemorrhagic with each aliquot

Cell count and differential

- Alveolar macrophages (Normal >80%)
- Neutrophils (Normal <3%)
    - Nonspecific, but suggests active alveolitis
    - IPF, ARDS, infection, connective tissue disorders, Wegener's granulomatosis, pneumoconiosis
- Eosinophilia (Normal <1-2%)
    - Low to moderate eosinophilia (5-20%): Drug induced lung disease (e.g. minocycline, nitrofurantoin, penicillin), infections (parasitic, mycobacterial, fungal), asthma, malignancies (infrequently), other interstitial pneumonias occasionally (BOOP or COP, IPF/UIP, ILD associated with Connective tissue disorders)
    - Moderate to marked eosinophilia (>20%): ABPA, Churg-Strauss syndrome, Acute eosinophilic pneumonia, chronic eosinophilic pneumonia, idiopathic hypereosinophilic syndrome
- Lymphocytosis (Normal <15%)
    - Lymphocytosis can be found in a variety of conditions as listed below, but is not sufficiently sensitive and specific to recommend for routine clinical practice? Commonly noted associations are listed below.
        - Elevated CD4/CD8: Active sarcoidosis, berylliosis, asbestosis, Crohns disease, connective tissue disorders
        - Normal CD4/CD8: Tuberculosis, malignancies
        - Low CD4/CD8: Hypersensitivity pneumonitis, silicosis, drug-induced lung disease, HIV infection, BOOP (COP)
        - Others: Lymphoma, viral pneumonia, alveolar proteinosis

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- Erythrocytes
  - Elevated erythrocyte count - early sign of alveolar hemorrhage (first several hours)
  - Phagocytosed erythrocytes - alveolar hemorrhage within 48 hours
  - Hemosiderin laden macrophages - alveolar hemorrhage > 48hours

Microbiology

- Cultures
- Stains and Immunohistochemistry
  - Gram stain: Bacterial
  - KOH preparation: Fungal
  - Periodic acid-Schiff (PAS): Pulmonary alveolar proteinosis
  - Auramine-rhodamine, Auramine-O, or Ziehl-Neelson: Mycobacterial
  - Modified acid fast stain (Kinyoun): Nocardia
  - Silver methenamine: Pneumocystis carinii pneumonia, fungal
  - Direct fluorescent antibody testing (DFA) for Legionella
- Polymerase chain reaction (PCR)
  - Mycobacteria tuberculosis
  - Possible for numerous pathogens but clinical utility still unclear
- Quantitative or semiquantitative cultures
  - Particularly for ventilator associate pneumonia
    - Diagnostic of infection if organism identified:

-	Pneumocystis carinii
-	Toxoplasma gondii
-	Strongyloides stercoralis
-	Legionella pneumophila
-	Cryptococcus neoformans
-	Histoplasma capsulatum
-	Mycobacterium tuberculosis
-	Mycoplasma pneumoniae
-	Influenza A and B viruses
-	Respiratory syncytial virus

    - Colonization by organism possible:

-	Bacteria
-	Herpes, cytomegalovirus
-	Aspergillus
-	Candida
-	Atypical mycobacteria

Cytology

- Foamy macrophages
  - Nonspecific finding but can be seen in patients using amiodarone
- Malignancies
  - Lymphangitic carcinomatosis
  - Lymphoma
  - Bronchoalveolar carcinoma and other primary lung malignancies
  - Extrapulmonary malignancies
- Sulfur granules
  - Actinomycetes

- Hemosiderin Laden Macrophages
  - 20% is highly specific and sensitivie for alveolar hemorrhage, although a spectrum of findings can be seen depending on the timing and severity of the hemorrhage. Subclinical hemorrhage is thought to be possible at a level as low as 5%.
- Langerhans cells
  - >5% suggestive of Pulmonary Langerhans cell histiocytosis
  - Also CD1a (OKT6) or S100
- Cytomegalic cells
  - Viral pneumonias (cytomegalovirus, herpes)
- Oil red O stain
  - Indicates neutral fat droplets that can be seen in fat embolism
- Fat and Lipid stain (e.g. Sudan III)
  - Lipoid pneumonia (aspiration)
  - Lipid-laden alveolar macrophage index > 100 (Sensitivity of 100%, Specificity 57%)

Other

- Dust particle inclusions
  - Pneumoconioses, asbestos exposure
- Electron microscopy (Rarely indicated if ever for clinical purposes)
  - Birbeck granules or "X" bodies (pentilaminar cytoplasmic inclusions) - indicates Langerhans cells
  - Myelin like ultrastructure with lamellar bodies and myelin - alveolar proteinosis

Complications/Adverse events

- No complications in up to 95%
- Cough
- Transient fever (2.5%)
- Transient chills and myalgias
- Transient infiltrates in most (resolves in 24 hours)
- Bronchospasm (<1%)
- Transient fall of lung function
- Transient decrease in baseline PaO2
- In patients with already severely compromised respiratory status, the loss of lung function may necessitate the need for mechanical ventilation. Ideally, BAL in these patients should be avoided, but could be done after intubation if the patient progresses to this point.

Quiz Questions

1. **Bronchoalveolar lavage can be diagnostic in the appropriate clinical setting in all of the following EXCEPT:**

○	a) Pulmonary Langerhans cells histiocytosis
○	b) Pneumocystis pneumonia
○	c) Sarcoidosis
○	d) Eosinophilic pneumonia
○	e) Lymphangitic carcinomatosis

2. **In which of the following situation would a BAL be the LEAST helpful?**

○	a) A mechanically ventilated patient with radiographic infiltrates, fevers, and leukocytosis.
○	b) An HIV patient with increasing cough and dyspnea in the setting of interstitial infiltrates.
○	c) A 39 year old patient with hilar adenopathy and pulmonary infiltrates suspected of having sarcoidosis.

○	d) A patient with metastatic breast cancer now with progressive hypoxemia and a high resolution CT suspicious for lymphangitic spread.
○	e) An elderly man with clubbing, crackles, and progressive cough and dyspnea with a high resolution CT revealing honeycombing and interstitial infiltrates predominantly in a subpleural basilar distribution (i.e. strongly suggestive of usual interstitial pneumonitis)

3. **The predominant cell type in the cell differential from a BAL should be:**

○	a) Alveolar macrophages
○	b) Neutrophils
○	c) Mast cells
○	d) Eosinophils
○	e) Lymphocytes

4. **Alveolar hemorrhage can show all of the following features EXCEPT:**

○	a) Hemorrhagic alveolar return with the first aliquot of instillate
○	b) Elevated hemosiderin laden macrophages
○	c) Normal findings
○	d) Phagocytosed erythrocytes

5. **Which of the following is FALSE regarding possible complications of BAL?**

○	a) Fever and infiltrates suggest an infectious complication from the BAL due to inoculation of pathogens into the alveolar space
○	b) Bronchospasm may be prevented by warming the instillate solution and pretreatment with bronchodilators
○	c) Pulmonary infiltrates as a result of BAL have been reported to occur in up to 90% of patients
○	d) PaO2 can decrease, but is transient
○	e) Pneumothorax is not considered a complication of BAL

Get Score Start Over

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[Mini bronchoalveolar lavage in patients with severe respiratory failure].

[Article in Spanish]

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Abstract

BACKGROUND: To recognize the etiological agent responsible for severe acute respiratory failure (ARF) in patients in mechanical ventilation (MV) is important to determine their treatment and prognosis, and to avoid the excessive use of antibiotics. Mini bronchoalveolar lavage (mini BAL) is a blind, non bronchoscopic procedure, used to obtain samples from the lower respiratory tract from patients on mechanical ventilation (MV).

AIM: To assess the feasibility, complications and preliminary results of mini BAL among patients with severe ARF on MV.

MATERIAL AND METHODS: Prospective study in 17 patients with acute lung injury (ALI) or acute respiratory distress syndrome (ARDS) on MV and with negative conventional microbiological studies. Mini BAL was performed using standardized protocols. Hemodynamic and respiratory parameters where measured before and after the procedure. Samples obtained were sent to quantitative cultures.

RESULTS: At baseline: APACHE II score of 22 ± 6,7, PaO2/FiO2 ratio was 176.6 ± 48.6 and the oxygenation index was 9.74 ± 3.78. All procedures were performed by an ICU resident. Thirty five percent of the procedures had positive cultures and no complications related to the procedures were reported. The procedure lasted an average of 12 minutes and the instilled and rescued volume were 60 ml and 19.6 ml, respectively. There were no significant differences between hemodynamic and respiratory variables before and after the procedure.

CONCLUSIONS: Mini BAL is a safe, fast and easy technique for obtaining samples from the inferior airway in patients with ALI or ARDS on MV.

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Publication Types, MeSH Terms

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