

## Therapeutic applications of BAL

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Although BAL had been used for therapeutic purposes prior to its use as a diagnostic procedure and the value of BAL in the exploration and management of some interstitial lung diseases is now well established, its place in therapy is controversially reported. As early as 1963, RAMIREZ *et al.* [280] were the first to perform a whole lung lavage (WLL) using a large volume of fluid in patients with pulmonary alveolar proteinosis. Since then, this technique has been proposed to remove any alveolar filling material in conditions such as alveolar proteinosis [196, 281], alveolar microlithiasis [282], acute silicosis [283], or accidental inhalation of radioactive particles [289, 205]. Its use has also been proposed in obstructive lung diseases [286] to remove the mucus secretions accumulated in the bronchial tree as in asthma [287, 288] or in cystic fibrosis [289, 290]. This lavage differs from the segmental BAL currently used for diagnostic or research purposes in that it is performed under general anaesthesia, and uses a much larger fluid volume. The actual procedure varies slightly from one centre to another and has not yet been standardized [196, 291]. WLL is a safe procedure as shown by the absence of chronic side-effects over periods as long as 25 yrs in patients treated for pulmonary alveolar proteinosis (PAP) [192]. On the other hand, its efficacy is known to be dependent on the type of disorder in which it is performed.

We will briefly review the main pathological conditions in which WLL is currently performed.

### *BAL in alveolar proteinosis*

The benefit of therapeutic WLL is now well demonstrated in this disease. First proposed by RAMIREZ *et al.* [280], the technique has been slightly modified over the years. When the diagnosis of primary PAP is established, the decision to perform a therapeutic bronchopulmonary lavage should be based upon the patient's exercise tolerance and on his symptomatology, because spontaneous remission is always possible. When indicated, the performance of a WLL requires an experienced staff and considerable back-up facilities [196]. The first fluid samples to be recovered have a milky aspect which clears up progressively during the lavage. This treatment always improves the patient's symptoms [196, 281]. Some authors have shown a significant improvement of alveolar macrophage (AM) function after therapeutic WLL, demonstrating that the effect in AM function in PAP is reversible. Furthermore, this treatment could also reduce the rate of secondary infections [196, 281]. Although idiopathic forms of PAP are always improved by WLL, the periodicity of the need for therapeutic BAL varies widely from one patient to another, depending on the individual course of the disease.

In case the clinical symptoms do not dramatically improve after a whole lung lavage, a clinical and patho-

logical search should be made for an associated condition; an open lung biopsy is then required to eliminate, for instance, acute silicosis, infections and/or malignancy [283, 293].

### *BAL in asthma*

Mucus plugs are known to contribute to the severe hypoxaemia in patients with status asthmaticus due to large ventilatory defect. These plugs can be removed by suction through a bronchoscope after the instillation of saline or acetylcysteine [287, 288]. However, this procedure was thought to have a high risk/benefit ratio. Some investigators have markedly improved the benefit of this technique by limiting the indications and through technical modifications. Clinical benefit is likely if tenacious mucus plugging or tracheobronchial casts are present. Nevertheless, despite this study [288], it seems that WLL in patients with severe asthma must still be considered as experimental in nature and performed in selected patients, by well-trained physicians with an extensive experience in this field and only in the context of an intensive care unit.

### *BAL in pneumoconiosis*

It is well known that inhaled inorganic dust damages the lung by inducing an inflammatory reaction that progressively leads to fibrosis. WLL has been proposed in order to remove the irritating dust before this irreversible damage occurs especially in the acute form of silicosis [294]. The lavage fluid is usually striking with its black or brown colour and numerous alveolar macrophages containing dust particles. It seems that the procedure results in rapid symptomatic improvement but without modification of the pulmonary function or the prognosis [294].

### *BAL in inhalation of radioactive particles*

The benefit of WLL in human contamination is not yet clearly defined [284, 285]. Experimental studies on dogs and baboons have been carried out over the last twenty years to determine the efficacy of WLL in the removal of such particles. It seems that, although the longer the radioactive material is present in the lung, the greater the dose delivered, WLL should not be performed in the early stages of contamination since it can prevent the usual physiological clearance of inhaled particles from the upper respiratory tract. WLL seems to be indicated in levels of contamination inducing acute effects, while its value in patients with lesser exposure is not clearly established.

### Other therapeutic applications of BAL

WLL has been proposed in the treatment of some other pulmonary disorders such as alveolar microlithiasis or exogenous lipoidosis, with some clinical but without any objective functional or radiological improvement [282].

In cystic fibrosis (CF), the benefit of WLL is also difficult to evaluate. It was expected that periodical repeated WLL could, if not arrest, at least slow down the progressive deterioration of lung function caused by the accumulation of bronchial secretions [289, 290]. Some authors have proposed WLL using anti-fungal drugs as a local treatment of aspergillosis,

a frequent complication of CF [290]. This requires further investigation.

### Conclusions

The therapeutic value of BAL is now perfectly established in alveolar proteinosis, which remains the only definite indication of this procedure. In other lung disorders, this technique still has a risk/benefit ratio which does not argue for its use in routine clinical practice. Its indication should be discussed for each patient and performed by an experienced staff in the context of an intensive care unit.

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