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Diagnostic Significance of Pleural Fluid Lactate Concentrations

**Summary:** Lactate concentrations in the pleural fluid and plasma of 57 patients with pleural effusions were measured by an enzymatic method. The mean pleural fluid lactate concentrations were significantly higher in patients with empyemas and rheumatoid arthritis than in patients with tuberculosis, cancer, non-specific pleural effusions and congestive heart failure. Pleural fluid lactate concentrations correlated significantly with pleural fluid lactate dehydrogenase activities and inversely with pleural fluid glucose concentrations. An elevated pleural fluid lactate concentration is not diagnostic for empyema, as most patients with rheumatoid arthritis and some with tuberculosis and cancer also show high values.


**Introduction**

Low pleural fluid glucose levels and pleural fluid acidosis occur in empyema and rheumatoid pleurisy and have been reported in some cases of tuberculous pleurisy and pleural effusions due to malignant tumours (1, 2). Local production of lactate and CO₂, the end products of anaerobic glucose metabolism, seems to be responsible for pleural fluid acidosis (3).

The determination of lactate in body fluids has been used mainly for the detection of bacterial infections. High levels of lactate have been reported in cerebrospinal fluid in bacterial meningitis (4–6), in synovial fluid in bacterial arthritis (7) and in pleural fluid in bacterial empyema (8). In order to evaluate the diagnostic usefulness of pleural fluid lactate determinations, we measured the concentration of lactate in the pleural fluid and plasma of patients with pleural effusions due to many different causes.

**Patients and Methods**

The patient series consisted of 57 adults admitted to hospital for the diagnostic evaluation of a pleural effusion. Pleural fluid was analysed cytologically and stained and cultured for the presence of bacteria, including *Mycobacterium tuberculosis*. Total and differential leukocyte counts, protein, lactate dehydrogenase (LDH), glucose, rheumatoid factor, anti-nuclear antibody and complement components C3 and C4 were determined in all pleural fluids.

The patients were grouped into six categories on the basis of the final diagnosis: 1) Seven patients had empyema as defined by gross appearance of pus in the pleural space. Five empyemas were culture-positive: in three there was only a single organism (*Streptococcus pneumoniae, Staphylococcus aureus* or *Escherichia coli*), while in two, multiple organisms were recovered (*S. aureus* and *Streptococcus faecalis* in one and *S. aureus, S. faecalis* and *Streptococcus β-haemolyticus* in one). 2) Five patients had rheumatoid arthritis as diagnosed according to the criteria of the American Rheumatism Association. 3) Nine patients had tuberculous pleurisy. In eight the diagnosis was verified by a positive culture of *M. tuberculosis* and in one it was based on clinical findings and a positive response to specific anti-tuberculous therapy. 4) Fifteen patients had pleural effusion due to a malignant tumour. Eleven of these patients had pulmonary carcinoma: five adenocarcinomas, three epidermoid carcinomas, one oat-cell carcinoma and two unclassified carcinomas. Two patients had renal carcinoma and two malignant mesothelioma. 5) Eighteen patients had non-specific exudative pleural effusion. Six of these patients had pneumonia, one had pancreatitis, one had an eosinophilic pleural effusion and one probably had a pulmonary infarction. In nine patients the etiology of the pleural effusion remained totally unknown. 6) Three patients had congestive heart failure and transudative pleural effusion (protein concentration in pleural fluid < 30 g/l).

For the determination of lactate, pleural fluid (taken at the first diagnostic puncture) and blood (fasting value taken the same morning) were collected into fluoride EDTA tubes. The determination was performed with an enzymatic method (Boehringer Mannheim AG, Germany). The reference limits for lactate in plasma (0.63–2.44 mmol/l) are based on the fasting morning values of 76 hospital personnel.

The Student’s t-test and linear regression analysis were used for statistical calculations.

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Results

Figure 1 shows the range of lactate levels in pleural fluid from the various patient groups. Mean pleural fluid lactate concentrations were significantly higher in patients with empyema or rheumatoid arthritis than in patients with tuberculosis (p < 0.001 and p < 0.01, respectively), cancer (p < 0.001), non-specific pleural effusion (p < 0.001) and congestive heart failure (p < 0.01). Patients with tuberculosis had a significantly higher mean pleural fluid lactate concentration than patients with non-specific pleural effusion (p < 0.001) and patients with congestive heart failure (p < 0.01).

The concentrations of lactate in plasma are shown in Table 1. No statistically significant differences between the mean values of the groups could be observed. Table 1 also shows the pleural fluid-plasma lactate ratios. In all patient groups, the mean pleural fluid lactate concentration was significantly higher than the mean plasma lactate concentration. The mean pleural fluid-plasma lactate ratio was significantly higher in patients with empyema than in patients with cancer (p < 0.01) and non-specific pleural effusion (p < 0.001), and significantly higher in patients with rheumatoid arthritis than in patients with cancer (p < 0.01), non-specific pleural effusion (p < 0.001) and congestive heart failure (p < 0.01).

Table 2 shows the leukocyte counts and protein, LDH and glucose concentrations in pleural fluid from the various patient groups. There was no correlation between pleural fluid lactate concentrations and pleural fluid leukocyte counts or protein concentrations, nor did pleural fluid lactate correlate with plasma lactate. Pleural fluid lactate concentration, however, correlated positively with pleural fluid LDH activity (r = 0.523, p < 0.001) and inversely with pleural fluid glucose concentration (r = -0.832, p < 0.001).

Discussion

The determination of lactate in pleural fluid, synovial fluid and cerebrospinal fluid has been reported to be useful in the diagnosis of bacterial infections (5, 7, 8). However, in a recent study it was shown that the cerebrospinal fluid