THE PATHOGENESIS OF PNEUMONIA IN SHEEP

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Maurice Rewi Alley

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ABSTRACT

The pathology of pneumonia in sheep in New Zealand is described in a study of over 400 naturally-occurring cases obtained from field and abattoir sources. The common forms of enzootic pneumonia consist of two distinct pathological and epidemiological entities; an acute pneumonia affecting sheep of all ages and a subacute or chronic, non-progressive pneumonia affecting lambs from approximately 3 to 10 months of age. Acute pneumonia is characterised by intense congestion, alveolar haemorrhage, fibrinous exudation and ventral consolidation of both lungs. Ultrastructurally the cellular exudate consists of a mixture of neutrophils, macrophages and detached alveolar epithelial cells with which bacteria are closely associated. Subacute and chronic pneumonia is characterised by varying degrees of dull red to grey consolidation of the anterior lobes. Ultrastructural studies reveal a variety of degenerative changes in the alveolar epithelium including several subcellular changes not previously recorded. Repair is by type II cell hyperplasia and this has been studied ultrastructurally and histochemically. Undifferentiated type II cells resembling those found in the foetal lamb and cells transitional between type II and type I have been observed. The significance of these findings in relation to the origin and dynamics of alveolar epithelial repair is discussed. The major factor underlying the pathological differences between acute and chronic pneumonia is considered to be the degree of damage to the alveolar epithelium which is universal in the former disease and less severe and localised in the latter.

Experimental injury to the ovine lung produced by the endobronchial instillation of dilute (1%) nitric acid with India ink as a marker was studied at periods from 2 hours to 10 days after administration. Alveolar collapse and neutrophil infiltration were the earliest changes seen but few neutrophils remained after 3 days. Large macrophages which were active from 3 hours were joined by smaller macrophages which migrated from interstitial tissues from 12 hours until 3 days after administration. The ultrastructural changes observed in the alveolar epithelium were similar to those encountered in naturally-occurring pneumonia. Proliferation of Clara cells and type II cells was detected

one day after administration and partial "epithelialization" of some alveoli at 5 days. There was complete loss of pulmonary surfactant from affected areas by 12 hours and return to normal activity was irregular.

Parentally administered Paraquat and oral dosing with busulphan were also tested for their value as agents for producing experimental pulmonary injury in sheep. Maximum pulmonary involvement occurred at between 6 to 10 mg/Kg of Paraquat but death appeared to result from liver and kidney toxicity. Paraquat pre-treatment did not affect pulmonary resitance to endobronchially inoculated bacteria in pure or mixed cutures, however lesions similar in nature to those of acute enzootic pneumonia were produced by Staphylococcus aureus. No significant pulmonary effects were produced with busulphan at high dose rates.

To investigate the bacterial flora of the respiratory tract of normal and pneumonic sheep, 184 normal sheep and 246 sheep aged 6 to 9 months with chronic or subacute pneumonia were examined at slaughter over a 2 year period. Pasteurella haemolytica was present in the nasal cavities of 73% of normal sheep and 78% of sheep with pneumonia, while Neisseria catarrhalis was also commonly isolated from both classes. Pneumonic lungs characterised by alveolar collapse yielded few bacteria whereas those in which cellular exudate predominated contained P. haemolytica in 75% of cases. In lungs with severe proliferative changes P. haemolytica was recovered in over 60% of cases and N. catarrhalis in 25 to 33%.

The prevalence of Mycoplasma ovipneumoniae and Mycoplasma arginini was also investigated in the respiratory tract of normal and pneumonic 6 to 9-month-old sheep. Both organisms were ubiquitous in the nasal cavity but M. ovipneumoniae was recovered more frequently than M. arginini. The recovery rate and titre of M. ovipneumoniae in pneumonic lungs were substantially higher than in normal lungs and several proliferative histological features were found to be associated with these titres. Cellular exudation and epithelial hyperplasia were associated with combined high titres of M. ovipneumoniae and bacteria. Lymphoid hyperplasia and mucus secretion were associated with low bacterial titres.

Transmission experiments with lung homogenate derived from cases of acute pneumonia succeeded in producing lesions similar to the natural disease when inoculated endobronchially into worm-free, housed lambs whereas cultures of P. haemolytica, M. arginini or pneumonic lung homogenised in medium containing antibiotic produced minimal or no effect. However, the excessive amount of inoculum and unnatural means of inoculation required suggested that host and environmental factors have a major role in the pathogenesis of the acute form of the natural disease.

Serial transmission of subacute and chronic pneumonia was achieved by intranasal aerosol inoculation of lung homogenate derived from abattoir cases. The clinical signs and pathological lesions were similar in most respects to the naturally-occurring disease. The pathological development of the lesions was studied in a further transmission experiment in which 12 lambs were slaughtered sequentially from 2 to 12 days after inoculation. In studying the effect of various chemotherapeutic agents on the development of chronic pneumonia it was found that both ronidazole at 100 mg/Kg and oxytetracycline suppressed the development of the disease while tylosin and penicillin suppressed the development of the lesions without completely inhibiting the growth of micro-organisms.

A controlled experiment to assess the effect of pneumonia transmission on weight gain produced a significant reduction in the weight gain of treated animals but there was no correlation between the weight gain of individuals and pneumonic lesions. It was presumed that the result was due to a transitory systemic effect immediately following inoculation.

Intranasal inoculation of M. ovipneumoniae cultures produced lesions in 2 caesarian-derived lambs but inoculation of 9 worm-free housed lambs was unsuccessful.

The balance of evidence indicates that pneumonia in sheep, as it occurs in this country, results from the interaction of host and environmental factors with infectious agents. In acute pneumonia, bacterial multiplication in alveoli, presumably damaged by systemic agents, is

responsible for the destructive changes which occur. In chronic pneumonia bacteria from the nasal cavity actively contribute to the severity of the lesions but it is unlikely that they initiate the disease process. M. ovipneumoniae is also closely associated with the lesions of chronic pneumonia but further inoculation experiments and epidemiological studies are needed to define this organism's role more closely.

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Professor William Dick, 1794-1866
(From the lecture notes of John Gillispie, Veterinary Surgeon, who qualified from Dick's Veterinary College, Edinburgh in 1865).