Legionella pneumophila in coal miners

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ABSTRACT Legionnaires' disease was diagnosed in three mineworkers at a colliery. Investigation of water samples from various sites at the colliery did not discover a source of the infection. Results of serological surveys undertaken on the workmates of the patients and other miners showed only one additional positive *Legionella* indirect fluorescent antibody test. There was, therefore, no justification for any alteration in the water supply or the ventilation at the colliery.

The first recognised human infection with *Legionella pneumophila* occurred at a conference of the American Legion at Philadelphia.¹ Subsequently there have been many examples of this infection in various environments in the United Kingdom but only one account of the prevalence among coal miners² in which it was found that 4.7% of 150 miners had serological evidence of contact with the organism. The seven individuals concerned worked at six out of 12 separate mines surveyed. The prevalence was higher than that found in other groups investigated but did not suggest widespread exposure to *Legionella sp.*

Locally, our interest was stimulated by three coal miners from one colliery who were admitted to two local hospitals over a period of three years. All had pneumonia and positive legionella indirect fluorescent antibody (IFA) tests.

Case reports

PATIENT 1

A 56 year old miner was taken ill at home with an influenza like illness on 12 April 1979. He was a certified pneumoconiotic in receipt of a 10% disability allowance and was a smoker. He had not been abroad in the previous 12 months. His condition deteriorated and he was admitted to hospital after four days with fever, headache, severe myalgia, and vomiting. He had an enlarged liver and liver function tests showed decreased total protein and raised alkaline phosphatase, aspartate aminotransferase, alanine aminotransferase, and γ -glutamyl transpeptidase; urine analysis showed the presence

of albumin. Chest radiography showed left basal consolidation, but sputum culture was sterile. Cold agglutinins and blood culture tests were negative. Serology for *Legionella pneumophila* IFA using the Pontiac-1 strain as antigen was positive at a titre of 256-512 on the 25th day of illness. He was treated with Ampiclox 1 g intravenously every six hours but his condition deteriorated until intravenous erythromycin 500 mg every six hours was substituted on the ninth day; he then made a good recovery.

PATIENT 2

A non-smoking, fit young man with no medical history had left sided chest pain and had coughed up some blood. Although vaguely unwell, he was still at work. Chest radiography on 2 December 1980 showed pneumonia and his alkaline phosphatase was raised. Legionella serology on the third week of illness showed a positive IFA test with a titre of 256 against the Pontiac-1 strain. After the diagnosis of the third patient (see below) further IFA serology was carried out on this sample using other serogroup 1 strains with the following results:

	Pontiac-1	Knoxville	Bellingham	Hastings
Titre	128	128	256	256

During a brief spell in hospital he received oral erythromycin and recovered rapidly.

PATIENT 3

A 55 year old miner who was a heavy smoker became ill at work on 23 June 1982. He complained of sudden frontal headache and weakness. He was sent home where he became confused and was admitted to hospital. On admission, he was pyrexial and had a dry cough. He developed pneumonia over the next 48 hours. Chest radiography showed large opacities in the right mid zone and left hilar and

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lower zones. The liver function tests were abnormal, alkaline phosphatase, γ -glutamyl transpeptidase, and alanine and aspartate transaminases being raised. Detailed serological investigations were performed on a series of serum samples as diagnostic IFA titres were not obtained against the Pontiac-1 strain and the results are shown below.

He was treated initially with amoxycillin 500 mg every eight hours and Magnapen 500 mg every six hours without response. He was then given intravenous cefotaxime 2 g and erythromycin 500 mg every six hours after which he made a good recovery.

Patients 2 and 3 drank moderately whereas patient 1 drank more than five pints of beer a night. None had been abroad before their illness.

Material and methods

MINERS SURVEYED

Serological surveys were performed on the following groups:

(a) Miners who had worked either in direct contact with patient 1 or had worked in the same environment before his illness. (b) A random sample of the workforce at the colliery. (c) Miners from the colliery participating in an epidemiological project and selected for study on the basis of respiratory ill health with evidence of emphysema. (d) Samples collected from other miners in south Wales who were certified pneumoconiotics and had attended the Pneumoconiosis Research Unit, Medical Research Council (MRC), Llandough Hospital, Penarth, South Glam.

Table 1 shows the number of men surveyed.

SEROLOGICAL TESTS

Serological tests were performed using the indirect fluorescent technique as used by Nagington *et al*⁴ with Pontiac-1 strain.

WATER SAMPLES

Water samples were collected in five gallon plastic containers from various sites in the colliery (tables 2 and 3). The sampling sites are indicated on the plan of the mine (figure).

Table 1 Prevalence of positive legionella serology in various groups

Surveys*	No tested	No positive
1	55	0
2	141	1
3	74	0
4	194	0

*See text.

LEGIONELLA ISOLATION

Isolation of Legionellae from water was attempted using the method described by Tobin *et al*.⁵

COLIFORM AND ESCHERICHIA COLI COUNTS

The coliform examination was carried out using a multiple tube method with confirmation of identity and differentiation of coliforms.⁶ When no or slight contamination was suspected the standard multiple tube method (1×50 ml, 5×10 ml, 5×1 ml) was used. When heavy contamination was suspected further dilutions of water were examined. Gray's improved formate-lactose-glutamate medium was used.⁷

TOTAL VIABLE COUNTS

Samples of water were diluted in half strength Ringer's solution, the dilutions ranged from neat to 1 in 10^6 . Plate counts were performed using 1 ml of each water dilution of 15 ml of cooled molten nutrient agar. These plates were incubated at 30°C for 48 hours. The colonies growing were counted and the total numbers were expressed per ml.

SURVEILLANCE OF SICKNESS RECORDS

All medical certificates submitted by workmen from the colliery were examined by the medical department. All men with respiratory illnesses were contacted and where necessary further information was obtained through their general practitioners.

Results

Table 1 shows the results of the various serological surveys. Only one of 270 (0.4%) workmates of the three cases had a positive Legionella IFA test as shown by positive antibody fluorescence at a titre of

Strain/date	Indirect fluorescent antibody titres			Microagglutination titres ³
	Pontiac-1	Knoxville-1	Hastings	Knoxville-1
1 7 82*	<16	<16	32	<2
9 7 82	16	32	128	32
9 8 82	16	16	256	4
6 9 82	16	NT	NT	NT

*Eighth day of illness.

Table 2 Results of water samples supply originating from mains

Source of sample	Plate count (Orgs/ml)	Count Orgs/100 ml		Legionella pneumophila
		Coliform	E Coli (Type 1)	
<i>Fitting shop</i>				
Blacksmith trough, patient 2	48 800	0	0	—
Blacksmith trough, unspecified	70 000	1	1	—
Blacksmith trough, unspecified	—	—	—	Not isolated
<i>Pithead baths</i>				
Header tank, unspecified	5 800	0	0	—
Header tank, hot	960	0	0	—
Header tank, cold	70	0	0	—
Header tank, unspecified	6	0	0	Not isolated
Shower spray, blue left	2	0	0	—
Shower spray, red right	1	0	0	—
Shower spray, (1)	—	—	—	Not isolated
Shower spray, (2)	—	—	—	Not isolated
Shower spray, unspecified	2	0	0	Not isolated
Shower heads*	16	—	—	—

*Shaken in 100 ml sterile Ringer's solution.

Table 3 Results of water samples supply originating from pit pond

Source of sample	Plate count (Orgs/ml)	Count Orgs/100 ml		Legionella pneumophila
		Coliform	E Coli (Type 1)	
Pit pond	10 200	180+	180+	—
Pit pond	—	—	—	Not isolated
Pit pond	2 560	160	90	Not isolated
<i>From supply</i>				
Hydraulic fluid (B110)	100 000‡	—	—	—
Hydraulic fluid (B110)	—	—	—	Not isolated
Hydraulic fluid (B104)	100 000‡	0	0	—
Hydraulic fluid (B105)	100 000‡	180+	160	Not isolated
SAS ⁺ water supply (B105)	2 720	90	50	Not isolated
Tap (B104)	—	—	—	Not isolated
<i>From return</i>				
Underground sump, south dip	100 000‡	180+	17	—
Pumping station, Castell pump	15 200	180+	90	—
Fan drift*	100 000‡	—	—	—
Fan drift†	100 000‡	180+	13	—
Fan drift‡	—	—	—	Not isolated
Exhaust ventilation, slime in housing	18 700	—	—	—
Receiver tank, condensate	100 000	—	—	—
Main compressor, water (return)	4 480	—	—	—
Main compressor, water (return)	2 000	50	50	Not isolated

*Small sample.

†Eight hour sample.

‡Self advancing support.

1 in 16 or above. If the three cases are included four of 273 (1.5% of the workforce) in the suspect pit showed serological evidence of exposure to *Legionella sp.* Furthermore, none of the 194 sera received from the Pneumoconiosis Research Unit gave a positive result.

The water samples gave variable results. In general, as may be seen from table 2, when the water originated from the mains supply there was little evidence of faecal contamination and low plate counts. When it came from the pit pond (table 3) there was considerable evidence of faecal contamination and high plate counts. Despite this, none of the samples cultured for *Legionella sp.* yielded the organism.

Sickness absence records did not show any incidence of pneumonia among the rest of the workforce during the three year period.

Discussion

Three cases of Legionnaire's disease in the workforce of a single colliery, even over an extended period, raised the possibility of a common source "outbreak." The varying serological responses to different antigens, however, suggested that more than one strain was implicated (see case reports and results).

The offending micro-organism is well known to exist in water^{5,8,9} and particularly in man made water

Colliery water supplies and sampling sites

systems.¹⁰ Initially, therefore, it seemed appropriate to examine the colliery water supplies (see figure). Any area in the colliery where stagnant water accumulates might also have been a reservoir—for example, the underground sump, the exhaust venti-

lation fan housing, and the condensate in the receiver tanks for compressed air.

In this investigation samples of water from all these sites were examined, but *Legionella* sp was not isolated. Nevertheless, much bacterial contamina-

tion was evident where the water originated from the pit pond. Kurtz *et al* suggested a correlation between the presence of *L pneumophila* in closed systems and high total bacterial counts, warmth, dissolved solids, chlorides, and an alkaline pH.⁹ The presence of other micro-organisms helps to satisfy its growth requirements. The source of water in this case, however, was an open pond rather than the closed cooling tower that was the subject of their report. The latter may better provide the conditions in which *Legionella sp* can flourish. *Legionella* has also been isolated from shower units¹¹ but this was not the case here.

If the micro-organisms had been present in the colliery environment more cases of *Legionella* pneumonia might have been expected. This is particularly so since the miners working in the environment could be considered susceptible¹² because of pre-existing chest conditions such as bronchitis, emphysema, and chronic fibrosis¹³⁻¹⁵ that are commonly found in mining communities. In the event only three cases occurred in a two year period.

Little additional serological evidence of exposure to *Legionella sp* was found, either in the workmates of the affected individuals or in the sera of those with established pneumoconiosis received from the MRC unit. Further, no other suspected cases of *L pneumophila* infection were reported to the Public Health Laboratory Service or the National Coal Board Medical Service in South Wales during this period.

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