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An Abattoir Survey of Pneumonia and Pleuritis in Slaughter Weight Swine from 9 Selected Herds.

I. Prevalence and Morphological Description of Gross Lung Lesions

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Lium, B. M. and K. Falk: An abattoir survey of pneumonia and pleuritis in slaughter weight swine from 9 selected herds. I. Prevalence and pathomorphological description of gross lung lesions. Acta vet. scand. 1991, 32, 55–65. – The prevalence and pathomorphology of gross lung lesions were studied in 855 slaughter weight pigs from 9 selected herds in south-eastern Norway. Pneumonic or pleuritic lesions were found in 84 % of the lungs, ranging from 37 % in the least affected herd to 97 % in the one most affected. Bronchopneumonia indicative of a primary Mycoplasma hyopneumoniae infection was found in 70 % of the lungs, ranging from 9 % to 82 % in the individual herds. The amount of bronchopneumonic lesions in individual lungs ranged from 0 to 69 %, with an average of 7.8 %. Pleuropneumonia indicative of Actinobacillus (Haemophilus) pleuropneumoniae infection was found in 29 % of the lungs ranging from 0 in the least affected herd to 58 % in the most affected. Diffuse pleuritis was found in 41 % of the lungs and the prevalence ranged from 4 % to 63 %.

bronchopneumonia; pleuropneumonia; pathomorphology.

Introduction

Respiratory diseases are considered to be among the most worldwide and common problems in modern pig production (*Pijoan* 1986). The two main types of lung lesions of slaughter weight pigs are lobular bronchointerstitial consolidations of cranioventral lung regions, usually associated with *Mycoplasma hyopneumoniae* infections (*Ross* 1986), and acute or chronic pleuropneumonia or pleuritis, most frequently localized in the caudal lobes, and usually associated with *Actinobacillus pleuropneumoniae* infections (*Nicolet* 1986).

The type and severity of pneumonia in the pig are the result of a dynamic interaction between the infectious agents involved and the host, and are strongly influenced by the physical environment in which the pigs are kept and the management practices in the herd (*Aalund et al.* 1976, *Bäckstrøm & Bremer* 1978, *Tielen et al.* 1978, *Flesjå & Solberg* 1981, *Morrison et al.* 1986). Large-scale intensive pig production has turned out to be a factor causing aggravation and spread of lung infections. The economic losses caused by respiratory diseases are due to increased mortality, decreased rate of weight gain, decreased feed conversion efficiency and expenses for prevention and control programs (*Christensen* 1982, *Morrison et al.* 1985, *Wilson et al.* 1986).

In abattoir surveys from different countries the prevalence of lung lesions of pigs range from about 10 % to 90 % (*Edwards et al.* 1971, *Aalund et al.* 1976, *Bäckstrøm & Bre-*

mer 1978, *Flesjå & Ulvesæter* 1979, *Osborne et al.* 1981, *Burch* 1982, *Pointon & Sloane* 1984, *Morrison et al.* 1986, *Wilson et al.* 1986).

A few studies on the prevalence, extent and types of lung lesions of slaughter weight pigs have previously been reported from Norway (*Ødegaard* 1966, *Grøndalen* 1972, *Flesjå & Ulvesæter* 1979, *Bakke* 1983).

The purpose of this report was to study the prevalence of gross lung lesions in slaughter weight pigs from 9 selected herds in south-eastern Norway and to give a detailed description of the lesions observed. Histological, microbiological and serological findings are to be reported in other papers (*Falk* 1988, *Falk & Lium* 1991, *Falk et al.* 1991, *Høie et al.* in prep.).

Material and methods

Selection of herds

The investigation was initiated by the identification and selection of 9 field pig herds (herds A-D, J-K and S) of different sizes and management practices, all located in the south-eastern part of Norway. The herds were arranged into 3 groups according to the degree of respiratory problems. Group I comprised herds with severe respiratory problems (herds A-D). Group II comprised herds with subclinical to moderate respiratory problems (herds J-M) and in group III clinical information and previous abattoir recordings indicated no respiratory problems (herd S).

Herds A to C produced each about 3000 and herd D about 500 slaughter pigs per year. Herds J to M and herd S were closed farrow to finish herds each producing about 500 slaughter pigs per year.

The pigs in farms D, J to M, and S were given compound swine feed with no antibiotics added. The pigs in farms A to C were fed kitchen scraps.

Sampling procedure

Lungs and hearts from 855 pigs from the 9 selected herds were collected at 4 abattoirs without regard to the presence or absence of lesions. The lungs were immediately transported to the laboratory and further examined within 2–4 h.

Macroscopic examination

All the lungs were evaluated by the same person. The gross lesions were qualitatively grouped according to types of lesions: no gross lesions, bronchopneumonia, pleuropneumonia, abscesses, local fibrosis, diffuse pleuritis, pericarditis and "other lesions" including metastatic lesions.

The lungs were thoroughly palpated and sliced for inspection. All lesions were recorded on individual sheets prepared for this purpose and the extents of the lesions were drawn as accurately as possible in a diagram for each lung. Bronchopneumonia scores were calculated based on estimation of the approximate percent of lung surface with pneumonic tissue in each lobe. An overall bronchopneumonia score was then calculated as described by *Morrison et al.* (1985). The lungs were also scored for the number of focal necroses and/or fibroses.

Statistical analysis

Standard microcomputer software (SAS Institute Inc., Cary, NC, USA) was used to tabulate data and to perform descriptive statistics.

Results

The results of the gross examination are summarized in Tables 1 to 4. Gross lesions of pneumonia and/or pleuritis were recorded in 722 (84 %) of the 855 lungs examined. The prevalence of lung lesions ranged from 37 % in herd S to 97 % in herd D (Table 1).

Table 1. Frequency (%) of various gross lung lesions and pericarditis in 855 slaughter pigs from 9 Norwegian herds.

Herds		Frequency of gross lesions (%)*							
		Broncho-pneum.	Pleuro-pneum.	Abs-cesses	Local fibrosis	Diffuse pleuritis	Other lesions	Pericard-itis	No gross lesions
A	(N = 144)	64	37	18	35	63	4	8	6
B	(N = 195)	71	35	8	28	56	6	3	4
C	(N = 200)	71	38	6	21	43	4	6	12
D	(N = 62)	65	58	13	13	44	8	7	3
Group I	(N = 601)	68	39	10	26	52	5	5	7
J	(N = 53)	43	6	0	2	8	2	0	49
K	(N = 56)	57	0	2	0	4	18	0	30
L	(N = 58)	76	7	0	5	10	7	0	19
M	(n = 44)	48	14	0	9	41	7	23	23
Group II	(N = 211)	57	6	0.5	4	14	9	5	30
S	(N = 43)	9	2	0	5	9	16	0	63
Group III	(N = 43)	9	2	0	5	9	16	0	63
Total	(N = 855)	63	29	7	19	41	6	5	16

N = Number of lungs examined.

* Note that one lung may have more than one type of gross lesions.

Bronchopneumonia, the most frequently observed gross lesion, was found in 535 (63 %) of the lungs (Table 1). The prevalence ranged from 9 % in herd S to 76 % in herd L. The prevalence was significantly higher in group I compared to group II ($p < 0.01$).

The morphological changes recorded as bronchopneumonia varied from sublobular or lobular atelectatic areas of dullish red, firm lung tissue with a homogenous cut surface without exudate in the lumen of bronchi to swollen pale grey consolidations with edema fluid exuding from the cut surface and a grey, mucoid exudate in the bronchi. Some lungs recorded as bronchopneumonic had irregular, narrow bands of atelectatic and fibrotic tissue. Bronchopneumonic consolidations were sharply delineated from normal lung tissue.

The frequency distribution of bronchopneumonia scores is shown in Fig. 1. The mean value for affected lungs was 7.8 %, ranging from 0.4 % in herd S to 11.0 % in herd D

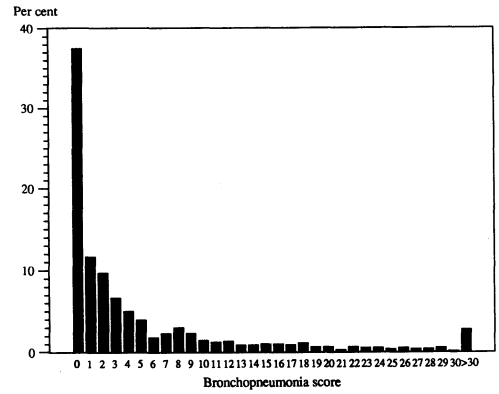


Figure 1. Frequency (%) distribution of bronchopneumonia scores in 855 pig lungs.

Table 2. Frequency (%) distribution of and mean bronchopneumonia scores of 855 slaughter pig lungs from 9 Norwegian herds.

Herds		Bronchopneumonia score 0	0–5 %	5–10 %	10–15 %	> 15 %	Mean score	Standard error of the mean
A	(N = 144)	36	35	8	7	13	8.3	0.96
B	(N = 195)	29	35	14	7	15	9.0	0.90
C	(N = 200)	30	46	10	5	11	7.3	0.89
D	(N = 62)	36	34	11	2	18	11.0	2.19
Group I	(N = 601)	32	39	11	6	13	8.5	0.53
J	(N = 53)	57	28	11	2	2	4.4	0.88
K	(N = 56)	43	38	9	4	7	5.9	1.37
L	(N = 58)	24	45	14	10	7	6.7	1.12
M	(N = 44)	52	32	11	2	2	4.1	1.00
Group II	(N = 211)	43	36	11	5	5	5.6	0.60
S	(N = 43)	91	9	0	0	0	0.4	0.10
Group III	(N = 43)	91	9	0	0	0	0.4	0.10
Total	(N = 855)	37	37	11	5	11	7.8	0.43

(Table 2). The bronchopneumonia scores for individual lungs ranged from 0 to 69 %. Lungs from herd S had a significantly lower score than all the other herds ($p < 0.01$).

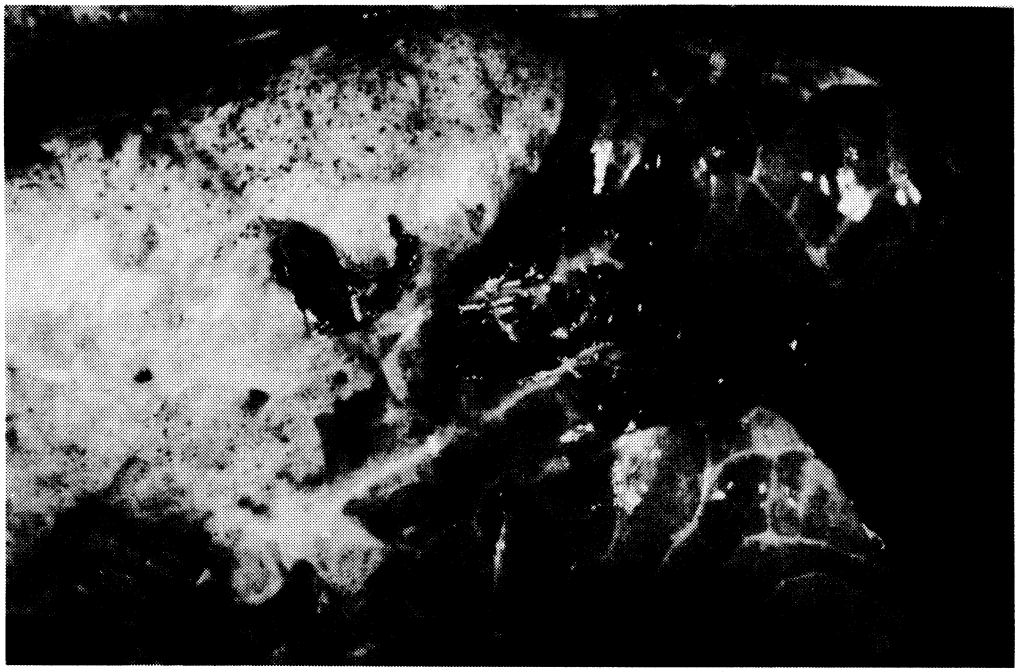
In bronchopneumonic lungs an average of 2.9 lobes were affected. The lesions were mainly confined to the cranioventral part of the lungs (Fig. 2). Frequency of involvement and mean score of different lobes in affected lungs are shown in Table 3. The middle lobes had a significantly higher frequency of bronchopneumonia than the other lobes ($p < 0.01$). The accessory lobe was the least frequently affected one, but had the highest bronchopneumonic score when involved and the caudal lobes had the lowest mean scores (Table 3). Bronchopneumonic lesions in caudal lobes were always localized to the cranioventral areas.

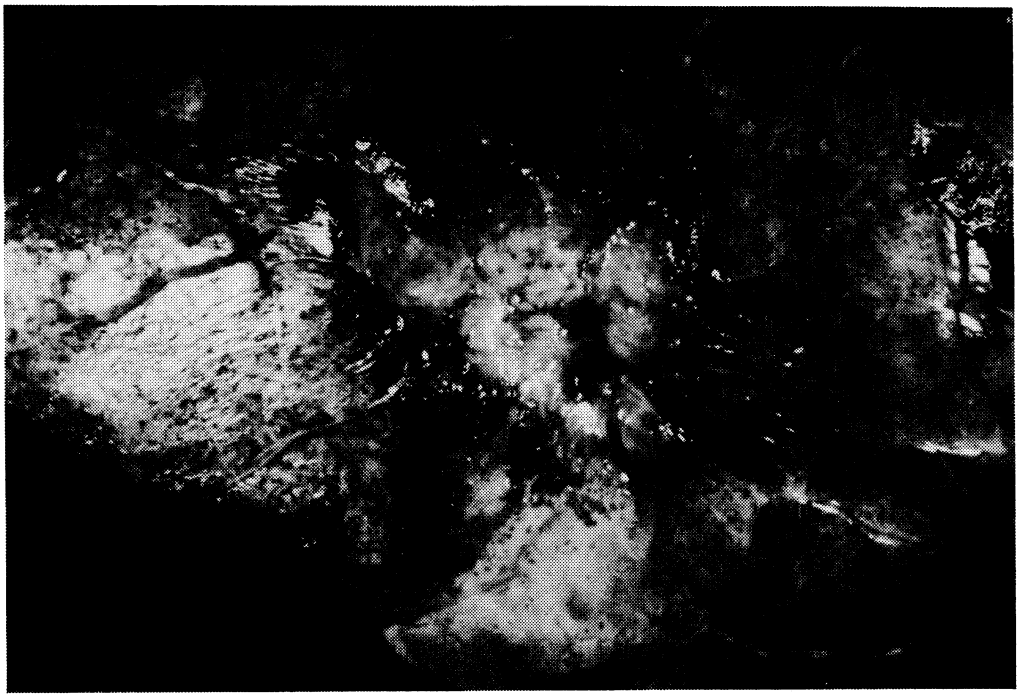
Table 3. Frequency (%) distribution and extent of bronchopneumonic lesions in different lobes of 535 pig lungs with positive bronchopneumonic score.

Lobe	Frequency of involvement	Mean score	Standard error of the mean
Right cranial	52	26.9	1.32
Right middle	64	30.9	1.40
Right caudal	25	9.0	0.84
Left cranial	34	34.3	1.99
Left middle	72	38.0	1.62
Left caudal	26	9.9	0.90
Accessory	22	41.9	2.55

Figure 2. Bronchopneumonia lesions, catarrhal type, involving the greatest part of the right cranial and middle lobes and cranioventral areas of the right caudal lobe.

Figure 3. Chronic pleuropneumonia lesion in dorsal aspects of the right caudal lobe showing pleural fibrosis and acute hemorrhage.





Pleuropneumonia was diagnosed in 248 (29 %) of the lungs, the prevalence ranged from 0 in herd K to 58 % in herd D and was significantly higher in group I compared to group II and III ($p < 0.01$) (Table 1). Lungs with acute or subaute pleuropneumonia were characterized by firm, irregularly shaped areas with extensive hyperemia and hemorrhages, greyish necrotic foci and prominent interlobular edema on the cut surfaces. The pleural surface was covered by extensive fibrin deposits. The lesions varied in size from a few to 6–8 cm in diameter and they were mainly localized to the dorsal parts of the caudal lobes, although some were also seen in dorsal areas of the middle and cranial lobes.

Chronic pleuropneumonic lesions were characterized by well demarcated necrotic or abscess-like nodules of different size, localized mainly to the dorsal parts of caudal lobes and associated with chronic, occassional adhesive, pleuritis (Fig. 3). The cut surface showed irregular, necrotic areas with a characteristic yellow-brown colour and a cheesy consistency. The necrotic masses were delineated by a thick fibrous capsule. Some of the chronic lesions were localized along bronchies in the central part of the dorsal lobes and could be detected only by careful palpation of the lung or on the cut surface. The number of chronic pleuropneumonic lesions varied from 0 to 14 per lung. The average number of lesions in affected lungs was 2.5.

Abscesses were found in 61 (7 %) of the lungs, ranging from 0 in herds J, L, M and S to 18 % in herd A. The prevalence in group I was 10 % while only 1 lung was affected in group II ($p < 0.001$). The suppurated areas were usually indurated and complicated by a chronic local pleuritis which was often adherent to the parietal pleura. The cut surface revealed multiple foci with a thick to cheesy, grey or yellow-green foul-smelling pus and surrounded by fibrous tissue.

Local fibrosis was found in 164 (19 %) of the lungs and the prevalence ranged from 0 in herd K to 35 % in herd A (Table 1). The prevalence was significantly higher in group I compared to group II and III ($p < 0.01$). The lesions counted in this category were characterized by local fibrotic thickenings of the pleura extending into the lung tissue. The fibrotic lesions were very often surrounded by extensive, acute hemorrhages in lungs from pigs stunned by electricity. Such hemorrhages were seldom seen in lungs from pigs stunned by CO_2 gas. The local fibroses were most frequently found in the dorsal parts of the caudal lobes.

Diffuse pleuritis, definited as chronic diffuse pleuritis affecting lung areas with no underlying pneumonia, was found in 346 (41 %) of the lungs (Table 1). The prevalence ranged from 4 % in herd K to 63 % in herd A and was significantly higher in group I compared to group II and III ($p < 0.01$). Herd M had a remarkably high prevalence of diffuse pleuritis compared to the other herds in group II. The pleuritic lesions varied from a moderate, diffuse thickening of the visceral pleura to extensive fibrotic adhesions between the visceral and parietal pleura and a massive loss of lung tissue when the lungs were exvicerated.

Chronic adhesive paricarditis was noticed in 42 (5 %) of the pigs and the prevalence was remarkably high in herd M compared to all the other herds examined (Table 1).

Bronchopneumonic changes were the only gross lesion in 206 (24 %) of the lungs, and the prevalence was significantly higher in group II compared to group I ($p < 0.01$) (Table 4). Pleuropneumonia and/or local fibrosis were the only gross lesions in 40 (5 %) of the lungs. Diffuse pleuritis without gross pneumonic lesions was recorded in 65 (8 %)

Table 4. Frequencies (%) of the combination of bronchopneumonia (BP), pleuropneumonia including local fibrosis (PLF) and diffuse pleuritis (DP) in 855 slaughter pigs from 9 herds.

Herds		BP+ PLF− DP−	BP− PLF+ DP−	BP− PLF− DP+	BP+ PLF+ DP−	BP+ PLF− DP+	BP− PLF+ DP+	BP+ PLF+ DP+	BP− PLF− DP−
A	(N = 144)	14	4	7	11	15	10	31	8
B	(N = 195)	16	5	9	19	17	10	20	5
C	(N = 200)	22	6	8	18	11	4	21	12
D	(N = 62)	13	15	7	24	7	8	23	5
Group I	(N = 601)	17	6	8	17	13	8	23	8
J	(N = 53)	38	2	4	2	4	0	0	51
K	(N = 56)	54	0	0	0	4	0	0	43
L	(N = 58)	60	0	5	10	4	0	2	19
M	(N = 44)	30	5	23	2	11	2	5	23
Group II	(N = 211)	47	1	7	4	5	0.5	1	34
S	(N = 43)	9	5	7	0	0	2	0	77
Group III	(N = 43)	9	5	7	0	0	2	0	77
Total	(N = 855)	24	5	8	13	11	6	16	18

of the lungs and the prevalence was remarkably high in herd M. The prevalence of all other combinations of pathological lung lesions shown in Table 4 were significantly higher in group I compared to group II ($p < 0.01$).

Discussion

The spectrum of gross lesions described in the present paper is in accordance with previous reports from similar surveys. The overall prevalence of lung lesions is, however, very high compared to most of the abattoir surveys previously reported (*Edwards et al.* 1971, *Bäckstrøm & Bremer* 1978, *Brassinne & Dewaele* 1976, *Flesjå & Ulvesæter* 1979, *Osborne et al.* 1981, *Morrison et al.* 1985, *Wilson et al.* 1986). The main reason for this is that most of the lungs examined in our survey were from pig herds selected for clinical signs of respiratory diseases. For the same reason, the prevalence of the different types of lung lesions reported, are not representative for, and should not be extrapolated to, the whole population of slaughter weight pigs in Norway. It should be noticed that a high prevalence of lung lesions was recorded also in the herd without clinical signs of respiratory problems.

In this connection it is important to consider that different methods for sampling lungs and recording lesions are important factors that make it difficult to compare the prevalences reported in different surveys (*Morrison et al.* 1986). By the technique used in this investigation, adapted from *Morrison et al.* (1985), even the slightest amount of gross lesions was recorded. This is much in contrast to the recording system used for example by *Flesjå & Ulvesæter* (1979) who defined the slightest lesions recorded, "mo-

derate pneumonia", as lesions affecting a minimum of 5 cm of the tip of a front lobe. Thus, the prevalence of macroscopic lesions should not be compared between surveys without accounting for differences in material and methods.

The gross bronchopneumonic lesions were very similar to those described for experimental *M. hyopneumoniae* infections in pigs (*Whittlestone* 1973, *Friis* 1974, *Livingstone et al.* 1972, *Hannan et al.* 1984), and they strongly indicated that all herds except herd S were infected with *M. hyopneumoniae*. This suggestion was confirmed by the microbiological examination which clearly showed that *M. hyopneumoniae* was the most significant etiologic agent isolated from the bronchopneumonic lesions (*Falk et al.* 1991).

The distribution of bronchopneumonic lesions among lung lobes is in agreement with previous abattoir surveys (*Edwards et al.* 1971, *Brassine & Dewaele* 1976, *Osborne et al.* 1981, *Morrison et al.* 1985). The higher rates of affection in the middle lobes compared to cranial, intermediate and caudal lobes are highly significant and can probably be ascribed to anatomical and mechanical factors (*Edwards et al.* 1971, *Livingstone et al.* 1972, *Whittlestone* 1973).

Grossly swollen, pale grey and edematous bronchopneumonic areas are thought to represent acute lesions of mycoplasmal infection, while bands of darkly red, atelectic areas are thought to represent chronic, resolving mycoplasmal lesions. This suggestion is supported by the histological findings in the present material (*Falk* 1988) and is in accordance with experimental studies of the sequential steps of the development and resolution of lung lesions induced by *M. hyopneumoniae* (*Pointon et al.* 1985, *Hannan et al.* 1984). Suppuration in bronchopneumonic lesions is caused by secondary bacterial infections, and a high frequency of such complications, as seen in group I, strongly indicates unfavourable environmental conditions and management.

The gross morphology of lesions recorded as pleuropneumonia in this survey was very similar to those described as *Actinobacillus (Haemophilus) pleuropneumonia* associated lung lesions in previous field studies (*Nielsen* 1970a, *Grøndalen* 1972, *Didier et al.* 1984, *Nicolet* 1986), and the acute lesions were in accordance with the description of acute stages of experimental *A. pleuropneumoniae* infections of pigs (*Nielsen* 1970b, *Didier et al.* 1984, *Liggett & Harrison* 1987). *Christensen* (1981) stated that a high frequency of chronic pleuritis of slaughtered pigs strongly indicates a previous infection with *A. pleuropneumoniae*. Chronic pleuritis has, however, also been related to infections with *Mycoplasma hyorhinis, Haemophilus parasuis* and *Pasteurella multocida* (*Farrington* 1986, *Nicolet* 1986, *Ross* 1986).

Herds with high prevalence of pleuropneumonia also had a high prevalence of diffuse pleuritis. The lungs showed all stages from acute hemorrhagic or fibrinonecrotic pleuropneumonia via necroses surrounded by fibrous tissue to local fibrosis or chronic pleuritis without pneumonic lesions. These findings strongly indicate that these lesions may represent different stages of the same primary infection and that resolution of the pulmonary lesion may leave local fibrosis or a mild chronic pleuritis in an otherwise normal lung. This suggestion is further supported by the fact that pleuropneumonia and local fibrosis both were most frequently localized to the dorsal aspects of caudal lobes.

All herds in group I had a very high prevalence of pleuropneumonia, pleuritis and local fibrosis compared to most of the herds in group II and III. The only exception was

herd M which had a very high prevalence of diffuse pleuritis compared to other herds in group II. Herd M also had a significantly higher prevalence of pericarditis than all the other herds. This may be associated with the high prevalence of positive antibody titers to *A. pleuropneumoniae* serotype 7 in this herd (*Falk & Lium* 1991).

In conclusion, this survey shows that respiratory diseases may be very common in slaughter weight pigs in Norway. However, it is important to emphasize that the lesions registrated at slaughter represent just one phase of a dynamic process. This is especially important to bear in mind when morphological lesions are compared to microbiological or serological findings, or when economical effects are to be estimated from the gross lesions found at slaughter.

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Sammendrag

En slaktehusundersøkelse over pneumoni og pleuritt hos slaktegris fra 9 utvalgte besetninger. I. Forekomst og morfologisk beskrivelse av lungelesjoner.

Lunger fra 855 slaktegriser fra 9 utvalgte besetninger i sydøst-Norge ble samlet inn ved slakting og undersøkt med henblikk på pneumoni og pleuritt. Slike lesjoner ble funnet i 84 % av lungene. Frekvensen i de enkelte besetningene varierte fra 37 % til 97 %.

Bronkopneumoni som kunne tyde på primær *Mycoplasma hyopneumoniae* infeksjon ble funnet i 70 % av lungene. Frekvensen i de enkelte besetningene varierte fra 9 % til 82 %. Utbredelsen av bronkopneumoniske lesjoner i den enkelte lunge varierte fra 0 til 69 % med en gjennomsnittlig utbredelse på 7.8 %.

Pleuropneumoni som tydet på infeksjon med *Actinobacillus (Haemophilus) pleuropneumoniae* ble funnet i 29 % av lungene med variasjon fra 0 til 58 % i de enkelte besetningene. Diffus pleuritt ble funnet i 41 % av lungene. I de enkelte besetningene varierte denne frekvensen fra 4 % til 63 %.

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