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The relationship between abnormalities detected in live lambs on farms and those detected at post mortem meat inspection

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SUMMARY

A prospective longitudinal study of diseases of lambs born in December and January and housed through to slaughter was carried out on three flocks (A, B and C) between 1989 and 1991. In the first year of the investigation (1989–90) three cohorts of approximately 80 lambs were examined in detail on a regular (weekly or fortnightly) basis. This involved over 2000 examinations and at least one clinical abnormality was observed in each lamb. In the second year (1990–1) the farmers were asked to present sick lambs for treatment on the farm. Farmers from flocks A and B participated in this part of the study; a total of 97/1295 lambs that were slaughtered received at least one treatment.

The carcases and visceral organs of lambs from each flock were observed after slaughter. There was no association between the abnormalities observed during routine examination of the cohort lambs (year 1) and those observed at post mortem meat inspection. However, in year 2, in lambs from flock A, there was a significant association between lambs treated for arthritis or pneumonia on the farm and the presence of arthritic or pleuritic lesions, respectively, post mortem. In both years of the study lambs which were older when slaughtered were significantly more likely to have pleuritic, pneumonic or arthritic lesions at meat inspection.

It was concluded that routine examination of groups of lambs is an inefficient and possibly ineffective method to identify lambs with lesions at slaughter. However, lambs which have been treated for disease, and the older lambs in a flock, had an increased prevalence of lesions post mortem and hence more detailed inspection of these animals would increase the efficiency of meat inspection.

INTRODUCTION

Meat inspection was introduced in the late 1890s to prevent zoonotic disease passing to man. The primary zoonoses at that time were tuberculosis, brucellosis and anthrax [1]. Cattle infected with tuberculosis had visible abnormalities (e.g. caseous lymph nodes) and could therefore be identified and rejected for human consumption [1]. Meat inspection is still a useful technique to ensure that carcases and organs with visible abnormalities are removed from the food chain. However, it is expensive and does not allow for detection of zoonotic microorganisms which may cause the infected animal no harm e.g. *Salmonella* spp. and *Campylobacter* spp.

The drawbacks of the current inspection system have led to a number of suggestions to improve its efficacy and efficiency. These include: on-farm identification of live animals likely to be rejected, so that meat inspectors can examine them in more detail [2] or ignoring organs not destined for human consumption unless they act as indicators for systemic disease [3]. Another method to improve efficiency is to improve the health of live animals and therefore reduce the

rejection rate and the time spent examining the carcases from these farms. One method suggested, to reduce carcase lesions, is to provide producers with information on the prevalence of abnormalities found at meat inspection together with suggested methods to reduce their occurrence. Producers who fail to reduce the prevalence of abnormalities can then be penalized [4]. Here, we report on the relationship between abnormalities detected in detailed examination of live lambs and of their carcases at meat inspection. In a prospective longitudinal study, two seasons of lambs from three flocks were examined from birth to slaughter and then their carcases were observed individually at the abattoir. The findings presented provide important information on the value of on-farm inspection.

MATERIALS AND METHODS

The farms

Three flocks of sheep situated in south-west England, which produced lambs for the Easter market, were observed over a 2-year period (1989–91). The lambs were born in December and January of 1989–90 (first year) or 1990–1 (second year). The ewes were induced to ovulate early in the breeding season (July–August) with intravaginal sponges impregnated with progestagen and pregnant mare's serum gonadotrophin. They were kept on grass until 2–6 weeks before lambing was due to commence. They were then housed in barns, on straw or softwood slats, with 40–200 ewes per pen. The lambs were born in these barns and then moved to individual mothering pens for 24 h. They were then moved to deep straw bedded barns, and fed a commercial concentrate ration and given water *ad libitum* from birth to slaughter. Before weaning lambs had access to the ewes' silage. However, no roughage, except bedding straw, was available to the lambs after weaning. The lambs were weaned when 6–8 weeks old and slaughtered from 9 weeks of age. The median age at slaughter was 15 weeks (range 9–26 weeks).

Study design

Two crops of lambs from the three flocks (A, B and C) were followed prospectively from 1989 to 1991.

In the first year, a cohort of approximately 80 lambs was randomly selected from each flock. The minimum prevalence of disease detectable from examination of a cohort of 80 lambs was 3·6% with 95% confidence levels [5]. Each lamb in the cohort was examined once every week until it was 6 weeks old. Half the lambs in each cohort were then examined and weighed each week, and the other half were examined and weighed every fortnight.

In the second year of the study, the farmers and shepherds from the three farms were asked to present any lamb from the flock, which they considered sick, for examination and treatment. Farmer C did not participate. The reasons for this are presented elsewhere [8]. The farms were visited daily during lambing and also daily when there was a sick lamb under treatment. At other times, daily contact with the farmers was made by telephone to identify newly diseased lambs. Each sick lamb was examined following the protocol developed in the first year of the study and treated by the researcher using drugs supplied by the farmer's veterinary practice.

The clinical examination

Each lamb was held by one researcher who sat on a straw bale with the lamb held against him/her and examined the lamb using the routine protocol. A second researcher recorded the results. The examination procedure was developed from a list of 265 potential abnormaliites. These were summarized and defined so that all visible abnormal clinical presentations could be described by site (e.g. eye, perineum), abnormality (e.g. swelling, discharge) and nature (e.g. fluid filled, purulent). The examination took approximately 4 min and started with the lamb's head. The lamb's identification number was recorded and then the skin around the head was examined for abrasions, infection or wool loss. Any indication of nervous disturbance was recorded. Then the lips were examined, the mouth was opened and the colour of the buccal mucosa was observed, discharge from the nose and eyes and the colour of the conjunctivae were recorded. Finally, the outside and inside of each ear were examined and palpated. This detail of examination was continued for the trunk, limbs and feet. Then the lamb's temperature was taken with a digital thermometer inserted into the rectum and placed against the rectal wall until the reading stabilized. Finally, the lamb was weighed using a spring balanced clock scale.

Examination of the cohort lambs (year 1) stopped when a lamb weighed 32 kg, or when the farmer thought a lamb was within 1 week of being finished, because handling a lamb within 1 week of slaughter

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Table 1. *The prevalence of clinical abnormality by flock in cohort lambs, year one*

Description of abnormality	Flock A		Flock B		Flock C	
	No.*	%†	No.	%	No.	%
Total slaughtered	66	100	67	100	79	100
Ocular						
Entropion	5	7·6	2	3·0	5	6·3
Conjunctivitis	66	100·0	67	100·0	61	77·2
Pale conjunctivae	14	21·2	18	26·9	6	7·6
Dermatological						
Facial orf	28	42·4	0	0·0	4	5·1
Facial *Staphylococcus aureus*	19	28·8	38	56·7	3	3·8
Perineal *Staphyloccocus aureus*	9	13·6	24	35·8	7	8·9
Thoracic						
Increased lung noise	66	100·0	67	100·0	75	94·9
Very increased lung noise	22	33·3	5	7·5	18	22·8
Alimentary						
'Empty' abdomen	3	4·5	4	6·0	0	0·0
Swollen abdomen	3	4·5	3	4·5	3	3·8
Diarrhoea	13	19·7	30	44·8	17	21·5
Perineal faecal staining	54	81·8	52	77·6	34	43·0
Locomotor						
Interdigital abscess	1	1·5	16	23·9	6	7·6
Foot scald	0	0·0	29	43·3	7	8·9
Lameness	1	1·5	0	0·0	2	2·5
Fracture	2	3·0	1	1·5	0	0·0
Nervous						
Central nervous	0	0·0	0	0·0	1	1·3

* No., number of lambs affected.
† %, percentage of cohort affected of those born.

may have resulted in bruising of the carcase. Examination of sick lambs (year 2) continued up to slaughter.

Farmers selected lambs for slaughter by checking their conformation, weight and fat cover. Lambs were finished at a variety of weights from 30 to 42 kg (mean 35 kg) and ages from 9 to 26 weeks (median 15 weeks).

Information recorded at the abattoir

All the lambs were slaughtered at one abattoir in south-west England. We had permission both from the owners of the abattoir and the meat inspectors (who work for the local authority) to record data on individual lambs on the slaughter line. We relied on their continued co-operation throughout the project.

Three people recorded data at the abattoir. One member of the research team recorded the ear tag number of each lamb after slaughter. The pluck (lungs, heart, visceral pleura, liver and non-muscular diaphragm) was removed from the carcase and hung on a separate moving line. To facilitate identification a numbered 'cloakroom' ticket was placed on the larynx.

The second and third researchers stood by the meat inspectors who examined the pluck and carcase respectively and recorded the abnormalities they observed.

There were a total of eight meat inspectors who rotated within a line every 20 min. Consequently, the inspection of carcases and plucks was frequently done by more than one meat inspector as each batch of lambs was dressed. Once the data collection was complete the conformation, fat grade and dead weight for each lamb were obtained from the MLC (Meat and Livestock Commission) records at the weighing point.

Data analysis

All the observations were coded and entered into a database (dBase III plus, Ashton Tate, Ashton Tate Corporation). Univariate analysis was performed in Epi Info 5 [5]. The significance probability was set at

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Table 2. *Number and percentage of lesions detected at slaughter in cohort and all flock lambs, year one*

Type of lesion	Number and % in three flocks combined		Number and % in three cohorts combined	
	No. (total 1821)	%	No. (total 212)	%
Thorax				
Pneumonia	110	6·0	13	6·2
Pleurisy*	1	0·2	1	0·5
Pericarditis*	8	0·4	1	0·5
Cysticercus ovis (heart)	26	1·4	5	2·4
Liver				
Parasitic tracts	35	1·9	3	1·4
Peritonitis	9	0·5	2	1·0
Abscesses	7	0·4	0	0·0
Other lesions	1	0·1	0	0·0
Carcase				
Bruising	35	1·9	0	0·0
Pleurisy	21	1·2	0	0·0
C. ovis (muscle)	18	0·1	0	0·0
Peritonitis	2	0·1	0	0·0
Fractured leg	1	0·1	0	0·0
Other lesions	20	1·1	1	0·5

* Pneumonia also present.

Table 3. *The number and percentage of lambs presented by disease and flock, year two*

Disease	Flock A		Flock B	
	No.*	%	No.	%
Ocular				
Entropion	14	1·8	7	1·0
Conjunctivitis	5	0·7	0	0·0
Dermatological				
Superficial wound	1	0·1	2	0·3
Thoracic				
Pneumonia	8	1·0	1	0·2
Upper respiratory tract noise	1	0·1	2	0·3
Alimentary				
Diarrhoea	12	1·6	11	1·6
Bloat	3	0·4	1	0·2
Locomotor				
Arthritis	23	3·0	5	0·7
Fracture	3	0·4	4	0·6
Interdigital abscess	2	0·3	1	0·2
Hyperflexed tendon	1	0·1	0	0·0
Nervous				
Listeriosis	8	1·1	0	0·0
Meningitis	2	0·3	3	0·4
Spinal abscess	1	0·1	1	0·2
Cerebrocortical necrosis	0	0·0	1	0·2
Other				
Septicaemia	1	0·1	0	0·0

* No., number of lambs recorded with disease.

0·05 for a two-tailed test. The associations between on-farm disease and postmortem lesions were investigated using Yates adjusted Chi square test or, where appropriate, Fisher's exact test, and the association between age at slaughter and the presence of postmortem abnormalities was investigated using Student's *t* test [6].

RESULTS

First year (1989–90)

There were 76, 75 and 80 lambs in the cohorts from flocks A, B and C out of 755, 594 and 763 lambs born respectively. A total of 640 (85%), 534 (90%) and 647 (85%) lambs from flocks A, B and C survived to slaughter and of these, 66 (87%), 67 (89%) and 79 (99%) were cohort lambs.

Over 2000 examinations of cohort lambs were carried out. All the lambs had one or more of the following clinical signs on one or more occasions: conjunctivitis, pale palpebral conjunctivae, entropion, staphylococcal dermatitis, orf, navel infection, increased respiratory noise, perineal faecal staining, diarrhoea, bloat, lameness, fractured leg, central nervous signs; the prevalence of each in the lambs surviving to slaughter is given in Table 1.

A total of 1821 lambs were monitored at the abattoir. The abnormalities recorded are listed in Table 2. Approximately 121 (6·6%) lambs had pneumonic lesions, 52 (2·9%) had liver lesions and 93 (5%) had carcase lesions (Table 2). There were 13/212 cohort lambs with pneumonic lesions at slaughter (Table 2); all 13 had 'increased respiratory noise' when alive, out of a total of 209 (98·6%) similarly affected lambs (Table 1). There was no significant association between pneumonic lung lesions at post mortem examination and 'increased respiratory noise' in clinical examinations (Fisher exact test, $P = 1·0$).

Second year (1990–1)

Of the lambs which were slaughtered, 67/669 (10%) and 29/626 (4·6%) lambs from flocks A and B were treated on one or more occasions. The following

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Table 4. *Number and proportion of lambs with post mortem abnormalities compared with those with ante mortem disease from flocks A and B, year two*

	Flock A (total 669)		Flock B (total 626)	
1990–1991	No.	%	No.	%
Type of lesion				
Thorax				
Pneumonia	28	4·7	49	7·8
Pleurisy*	5 (2/5)†	0·8	1	0·2
Pericarditis*	2	0·3	0	0·0
Cysticercus ovis (heart)	0	0·0	0	0·0
Liver				
Parasite tracts	8	1·2	7	11·2
Peritonitis	2	0·3	0	0·0
Abscesses	5	0·8	1	0·2
Other lesions	1	0·2	0	0·0
Carcase				
Cysticercus ovis (muscle)	0	0·0	0	0·0
Bruising	0	0	2	0·3
Pleurisy	11 (2/11)	1·6	7	1·1
Peritonitis	2	0·3	1	0·2
Arthritis	8 (5/8)	1·2	0	0·0
Other lesions	6 (2/6)	0·9	1	0·2

* Pneumonia also present.
† Number presented sick ante mortem.

Table 5. *Lesions associated with an increase or decrease in age at finishing*

Lesion	Site	Flock	Year	Days*	*t*	*P*
Arthritis	Carcase	A	2	+36	6·3	< 0·001
		C	2	+29	2·9	< 0·001
Pleurisy	Carcase	B	2	+26	4·3	< 0·001
	Thoracic	A	1	+15	2·3	0·01
		B	1	+13	2·0	0·04
		B	2	+33	3·5	< 0·001
Pneumonia	Thoracic	B	1	+11	3·8	< 0·001
		C	1	+13	3·7	< 0·001
Parasitic	Liver	B	1	−12	2·3	0·02
		B	2	−19	2·8	0·005

* +, increased age in days to finishing compared with lambs without lesion; −, decreased age in days finishing compared with lambs without lesion.

conditions were diagnosed: entropion, conjunctivitis, skin wound, pneumonia, URT noises, diarrhoea, bloat, joint ill, fractured leg, hyperflexion of tendons, interdigital abscess, listeriosis, meningitis, cerebrocortical necrosis (CCN), spinal abscess and septicaemia (Table 3).

There were 27/669 (4·0%) and 11/626 (1·8%) lambs with carcase abnormalities detected at meat inspection from flock A and B respectively (Table 4). Nine out of the 27 lambs from flock A had been presented as sick on the farm. There was a significantly greater proportion of post mortem lesions in the carcases of lambs from flock A, which had been presented as sick (9/67) compared with those not presented (18/602) (Fisher exact $P < 0·001$). Two out of the eight lambs with pneumonia (Table 3) had pleuritic lesions at meat inspection (Table 4) compared with 9/661 lambs (1·4%) not presented sick but which

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had pleuritic lesions at meat inspection (Fisher exact $P < 0{\cdot}001$). Also, 5/23 lambs (22%) presented by the farmers with joint ill (Table 3) had arthritic lesions at slaughter (Table 4) compared with 3/646 lambs (0·5%) not presented which had arthritic lesions at meat inspection (Fisher exact $P < 0{\cdot}001$). So, 2/11 (18%) and 5/8 (63%) lambs with pleuritic and arthritic lesions, respectively, at post mortem examination were identified with these diseases whilst alive (Table 4).

There was no association between lesions in the thorax or liver at slaughter and presentation for sickness in flock A (Table 4) and no sick lambs from flock B subsequently had post mortem lesions.

The association between age and post mortem lesions (years 1 and 2)

Lambs which took longer to mature, whether they had a recognized disease in life or not, had a significantly greater risk of arthritic (Flocks A and C, year 2), pleuritic (Flocks A and B, years 1 and 2) and pneumonic lesions (Flocks B and C, year 1) at meat inspection (Table 5). The increased age at slaughter ranged from an extra 11 to 36 days. Lambs from Flock B with liver lesions were significantly younger (approximately 12–19 days) than those without liver lesions (Table 5).

DISCUSSION

This study indicated that detailed routine clinical examination of lambs is not an effective way to identify those which are likely to have post mortem lesions; however, sickness is a useful predictor of abnormality at post mortem examination and those lambs from a cohort which are older at slaughter have an increased risk of arthritic, pleuritic and pneumonic lesions at meat inspection.

There was no association between observable, but mild, disease in live lambs examined routinely and lesions observed at meat inspection in year one. Only a very few of the lambs examined routinely on the farms had post mortem abnormalities; consequently the results from the individual flocks have been combined. The lack of association between observable disease in live animals and lesions at slaughter is important in the context of EU discussions on the use of on-farm examination of live animals to provide information on animal health prior to slaughter [1]. It is suggested that this should involve veterinary input from: routine herd inspections, health records, on-farm pre-slaughter examinations (including detailed examination of suspect animals), health certificates, identity checks and an assessment of the effects of transport to the abattoir. The cost of implementing these proposals will be enormous and may be prohibitively expensive for producers. Before they are introduced, decision-makers should consider the following:

On-farm, routine inspection of stock will be either very inefficient or ineffective. The lower limit of disease detection in this study was 3·6% per farm; it took 16 person-hours of time to examine each cohort of 80 lambs each week, i.e. 48 person hours per week. If it was sample size which prevented the detection of a true association between ante mortem disease and post mortem abnormality, then detection of an association at a lower prevalence than 3·6% would necessitate a larger sample size, an increase in the time required to complete the examinations and therefore greater expense. If ante mortem inspections were more cursory, detection of disease would be even less likely. We found no association between disease in the cohort lambs and post mortem lesions. This indicates that routine examination of animal cohorts may be entirely useless.

A more feasible approach may be to carry out a more detailed post mortem examination of lambs which have been treated for clinical disease since this identified a group which had suffered from pneumonia or arthritis. If all treated animals were permanently identified, e.g. with a standard coloured tag, then selective, detailed, examination of these lambs at the abattoir would be facilitated. We recommend that permanent identification of treated lambs, together with the inspection of farmer and veterinary treatment records, would be a sensible use of resources. Since farmers in the UK have to keep a record of veterinary medicines administered to their animals, recording individual animal identification and tagging treated animals would be useful both for disease and medicine residue detection at slaughter. This requirement could be readily incorporated into the appropriate legislation.

The association between an increased risk of pleuritic, pneumonic and arthritic lesions at meat inspection and an increased age at slaughter highlights the fact that certain abnormalities are more likely to be present in older lambs from one birth cohort. We consider it is likely that this would be the situation for all species of food animal, i.e. those that have taken longer than the optimal time to finish are more likely

to have some defect. However, since more than half the lesions detected occurred in young animals, and liver lesions were significantly more prevalent in younger lambs, failure to examine these animals would increase the risk of meat and offal with visible defects being distributed down the food chain.

The fact that liver lesions were more prevalent in younger lambs from Flock B was unexpected. Histological investigation of the lesions indicated that they were caused by a migrating parasite. It is possible that the lesions had healed in the older lambs, but this would not account for this age effect being present in Flock B only. Full details of these findings are described and discussed elsewhere [7]. Lesions indicative of *Cysticerucus ovis* were seen in Flock A in the first year of the study (Table 2). The farmers were advised to treat the farm dogs with anthelmintics routinely; *C. ovis* was not detected in the second year [7].

It is clear that not all meat quality issues can be managed successfully by identifying high risk animals on the farm. Therefore, one alternative approach is to reduce the prevalence of post mortem lesions. In Australia, farmers were provided with information on nine abnormalities detected in their sheep flocks with advice on how to control each problem. This was highly successful; the proportion of lambs with abnormalities decreased [4]. We also found that advice and intervention on the control of *C. ovis* was successful [7]. This approach would enable abattoirs to provide financial incentives to reduce abnormalities detected and therefore improve the efficiency of meat inspection because less time would be spent trimming and rejecting carcases.

There is clearly a need to improve the efficacy and efficiency of meat inspection and produce high quality meat. This can be done, in part, by identifying lambs which have received veterinary treatment during their life, and older animals in a cohort, and placing greater emphasis on their inspection after slaughter. However, neither of these approaches is sufficiently sensitive to remove the need for routine examination of every slaughtered lamb.

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