Lung Lesions in Feeder Cattle at Slaughter: A Proposed Method for Lesion Recording, and Lesion Effects on Calf Growth and Carcass Traits[a]

Lonty K. Bryant, *DVM;*
Louis J. Perino, *DVM, PhD;*
D. Dee Griffin, *DVM, MS*
University of Nebraska
Great Plains Veterinary Educational Center
P.O. Box 187
Clay Center, NE 68933

Alan R. Doster, *DVM, MS, PhD*
Veterinary Diagnostic Center
University of Nebraska-Lincoln
Lincoln, NE 68583-0907

Catherine E. Dewey, *DVM, MSc, PhD*
Department of Population Medicine
University of Guelph
Guelph, Ontario
Canada N1G 2W1

Thomas E. Wittum, *PhD*
Department of Veterinary Preventive Medicine
The Ohio State University
1900 Coffey Road
Columbus, OH 48210

Introduction

Decreased growth in beef calves with clinical pneumonia is reported in veterinary literature. Conversely, several studies found no impact on mean daily gain (MDG) between calves that develop clinical disease and those that do not. Explaining the published discrepancies concerning the effects of pneumonia on growth and performance is necessary to understand its true financial impact. Additional studies are needed to develop methods of detecting clinical or asymptomatic disease. Vaccine and pharmaceutical efficacy studies traditionally have been conducted using mortality and morbidity as the outcomes of interest. These are important parameters, but as pilot studies show,[1] asymptomatic disease can be equally significant on calf growth and possibly carcass traits.

Evaluation of animal interaction with management, environment, and disease occurrence plus evaluation of lesions at slaughter should provide new information on disease development and may lead to a better understanding of the respiratory disease process and its cost. Standardized methods of recording and investigating each lesion's significance on calf growth and carcass traits are needed.

Disease monitoring in the swine industry

Disease monitoring in the swine industry has been done through slaughter checks since the 1960's.[2] Slaughter examinations are used to detect the presence of either subclinical disease or clinically evident disease complexes. A recent study evaluated a rapid subjective method that estimated the extent of gross pneumonic lesions in slaughtered pigs with detailed dissection of the lungs.[3] They concluded that the rapid method was

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highly predictive (R2 = 0.88) of the pneumonic lesions that were present. The authors suggested that visual lung scoring, adjusted for actual lobe proportions, was adequate for estimating pneumonia when researching naturally acquired disease.[3] In a separate study, the Pearson's correlation coefficient between rapid gross examination and histological examination of lungs was 0.94.[4] The Kappa values for this study between inspectors were 0.95, representing almost perfect agreement.[4] Every 10% of the pig's lung affected with pathology equates to a depression in growth of 37.4 grams.[5]

These reports suggest that rapid visual methods for scoring lungs can be highly correlated with detailed histological examination of lungs and are repeatable between inspectors. These techniques are used primarily to identify well-recognized lesions produced by Mycoplasma and Hemophilus species. Similar conditions are not documented in cattle at slaughter. Therefore, the cattle industry needs to derive its own standardized system for evaluating pathology existing in the lungs of cattle at slaughter.

Measuring disease in cattle at slaughter

Griffin reported standard operating procedures for disease monitoring in cattle at slaughter.[6] Griffin and Perino described disease detection in cattle at packing plants.[7] Besides these publications, routine inspection of beef cattle at slaughter by the private sector is limited to monitoring liver pathology (ELANCO©) and the assessment of quality control defects and pathology associated with these defects by the National Cattlemen's Beef Association.[8,9]

Routine inspection of liver pathology is done by trained personnel. Evaluating this pathology allows estimates of potential loss in growth during the feeding period due to the occurrence of this pathology. Recording liver pathology at slaughter is done by scoring livers as follows: normal = 0 ; one or two small abscesses or abscess scars present (less than 2.5 cm diameter) = A- ; two to four active abscesses (generally less than 2.5 cm in diameter) = A ; or one or more large active abscesses (greater than 2.5 cm in diameter) = A+ (other structures are often adhering to the surface of the liver in this class).[10]

Two separate studies describe recording and/or scoring lesions present in the lungs of cattle at slaughter.[11,12] Both publications alluded to recording lung pathology on standardized forms, however, the forms and methods of scoring were not published.

The classifications in Table 1 were used when describing lung and pleural lesions that were present at slaughter.[13] The authors estimated the involvement for consolidation and pleuritis. Gross lesions were also recorded.

Table 1. Scoring system used by Mei (1987), for reporting lung pathology encountered at slaughter in veal calves.

Classification of lung lesions	
0	No or only some solitary consolidated lung lobules.
1	Various consolidated lung lobules; total extent clearly < half a lung lobe*.
2	The sum of the consolidated area(s) is about the extent of half a lung lobe.
3	The sum of the consolidated area(s) is about the extent of one lung lobe.
4	The sum of the consolidated area(s) exceeds the extent of one lung lobe.
Classification of pleura lesions	
0	No or only a solitary pleural adhesion.
1	Adhesive pleurisy extending over half a lung lobe.
2	Adhesive pleurisy extending over one or more lung lobes.
Pathomorphological classification	
A	Cuffing pneumonia/exudative pneumonia
B	Exudative pneumonia with bronchiectasis.
C	Abscesses and/or necrotic processes.

*Lobe: mean volume of the apical, cardiac and mediastinal lobes.

Lobe percentages were established in calf lungs by dissecting each lobe from its bronchi and weighing it.[14] These percentages are as follows: left cranial = 5%; left posterior cranial = 6%; left caudal = 32%; intermediate = 4%; right cranial =6%; right posterior cranial = 5%; right middle = 7%; and right caudal = 35%. Pathology in calf lungs at slaughter was then recorded on a lobar basis. This recorded pathology is adjusted by lobar percentages to calculate the amount of lung affected with lesions.[14] Griffin *et al.*, using these lung percentages,[14] recorded lung pathology in feedlot calves at slaughter;[15] however, descriptions of the terms used were not published with this reference.

A lung scoring sheet consisting of the topographical features of the bovine lung[16] is used for this project. Lesions in the lungs are recorded by lobe. Gross descriptions of lesions were consolidated, collapsed, adhesions (lobe-lobe, lobe-parietal pleura), pleuritis diffuse over the lobes or surface of the lung, or pleuritis diffuse involving the margins of the lung. Missing lobes were recorded as adhesions lobe-thorax. Abscesses were recorded as less than or equal to 2.5 cm, greater than 2.5 cm, or diffuse. Lesions not commonly seen were recorded as other; healed and bullous emphysema are two examples but this list continues to expand as new lesions are encountered. Lungs with extensive pathology (too involved to record at chain speed) were recorded as disseminated disease. Missed observations were recorded as missing observations, and lungs seen only on one side were recorded as half observations. The lungs that were condemned were recorded as such because of existing pathology or contamination. Consolidation, atelectasis and portions of lobes recorded as missing were calculated as continuous variables. The denominator for calculating each lobe contribution to total lung mass is from Jericho 1982[14] (software for scanning scoring sheets and automating this process is being investigated). These three lesions were recorded as continuous variables to investigate a possible threshold of disease and disease

processes over which animals cannot compensate, and thus growth and/or carcass traits are affected.

Validating chain speed observations

Lungs were scored at chain speed in runs of 20 and tagged with unique numbers, then pulled off line and scored again by a pathologist using the same system. Numbers recorded from this process appear in Tables 2 and 3.

Table 2. Lung lesions recorded during railed off inspection. Total lung/lobe counts, number with lesions, and the total number affected.

Variable	Total	Sum	Percent (%)
Lung lesion	130	107	82.3
Left cranial	130	16	12.3
Left cranial/caudal	130	45	34.6
Left diaphragmatic	130	66	50.8
Right cranial	130	52	40.0
Right cranial/caudal	130	55	42.3
Right middle	130	64	49.2
Right diaphragmatic	130	67	51.5
Accessory	130	8	6.2

Table 3. Lung lesions recorded at chain speed. Total lung/lobe counts, number with lesions, and the total number affected.

Variable	Total	Sum	Percent (%)
Lung lesion	98	61	62.2
Left cranial	98	5	5.1
Left cranial/caudal	98	20	20.4
Left diaphragmatic	98	47	48.0
Right cranial	98	24	24.5
Right cranial/caudal	98	26	26.5
Right middle	98	31	31.6
Right diaphragmatic	98	49	50.0
Accessory	98	4	4.1

Kappa values in Table 4 report clinical agreement after the first run of 20 lungs were excluded because they were misidentified and data on twelve additional lungs was excluded because observations at chain speed were missed. Table 5 contains the Kappa values appearing in Table 4 plus the exclusion of eight additional lungs that were only observed on one side and subsequently recorded as normal at chain speed. Clinical agreement for the numbers in Table 4 is in the moderate range (.4-.6) at .554. Excluding lungs recorded as half observations removed two lungs correctly identified as normal, and six lungs that were incorrectly identified as normal (false negatives). Kappa value is raised to the substantial range (.6-.8) at .649. This information suggests that lungs scored at chain speed must be observed on both sides before scoring as normal.

Table 4. Diagnostic agreement between chain speed lung pathology and railed off gross inspection.

		Chain Speed Diagnosis		
		Lesion +	Lesion -	Totals
Gross Inspection	Lesion +	61	13	74
	Lesion -	5	19	24
	Totals	66	32	98

Observed Agreement	80
Potential Agreement	98
Expected Agreement	57.67
Observed Agreement beyond Expectation	22.32
Potential Agreement beyond Expectation	40.32
Kappa Value	0.553
Chi-square test for correlated proportions	2.722

Table 5. Diagnostic agreement between chain speed lung pathology and railed off gross inspection.

		Chain Speed Diagnosis		
		Lesion +	Lesion -	Totals
Gross Inspection	Lesion +	61	7	68
	Lesion -	5	17	22
	Totals	66	24	90

Observed Agreement	78
Potential Agreement	90
Expected Agreement	55.73
Observed Agreement beyond Expectation	22.26
Potential Agreement beyond Expectation	34.26
Kappa Value	0.649
Chi-square test for correlated proportions	0.083

Lung lesions in cattle at slaughter

Frequencies of lung lesions at slaughter are reported to range from below 1%[17] to 72%.[1] Secular differences in the occurrence of lesions have also been reported.[17] Portions of beef calves develop lesions from disease in the respiratory tract at some point in their

life. Fractions of these lesions persist until slaughter. Wittum, *et al.*, reported 72% lesion rate at slaughter.[1] One study concluded that 62.9 % of feedlot aged calves had histological changes indicative of pneumonia.[18] Griffin, *et al.*, reporting on lung lesion frequencies at slaughter, concluded that 50% of 143 animals examined had lesions.[15] Another study, reporting on pneumonic lesions at slaughter in 935 crossbred steers, showed results of lesion incidence ranging from 19.4 to 29.7% within different slaughter groups.[12]

Classes of cattle besides beef calves also had lung lesions present at slaughter. The lungs of 2,138 veal calves examined for pathological changes at slaughter revealed 17% had lung and/or pleural lesions.[13] It has been stated that 14.3% of 5,211 lungs collected from young beef calves at slaughter revealed evidence of gross and histopathologic changes reflecting previous pneumonia.[19] Other researchers, reporting the incidence of lung lesions in 1,196 apparent healthy adult animals, found that 20.9% were affected by various pathological conditions.[20]

The conclusion from these articles is that lung lesions at slaughter occur frequently in apparently healthy animals and in several age classes and types of cattle.

Lung lesions at slaughter and the effects on calf growth and carcass traits

Calves with lung lesions at slaughter have decreased Mean Daily Gain (MDG). Wittum, *et al.*, found calves with lung lesions at slaughter gain 0.076 kg/day less than those without lesions.[1] Crossbred beef/dairy calves with lung lesions at slaughter had increased days on feed and reductions in MDG and carcass weights.[12] Veal calves in the Netherlands with lung lesions at slaughter had carcass weights reduced by 4.3 kg compared with their cohorts that lacked lesions.[13] The mean area of lung consolidation at slaughter was 2.99% in veal calves not treated for respiratory disease during the growing period. Calves receiving treatment for respiratory disease averaged 5.07% consolidation. Investigating lung lesion effect on live-weight gain, the calves were divided into groups, those with less and those with more than 5% consolidation. Calves in the group with more than 5% lung pathology had live weight gains 2.94% less than the other group.[11]

The current study reports on three groups of calves; one is a composite breed population[1] originating from the Roman L. Hruska U.S. Meat Animal Research Center (MARC), and the other two were commercial crossbred calves from private industry (groups 1 and 2). The scoring system described earlier was used to record lung pathology in these groups. Descriptive statistics are reported in Table 6. Data at the plant

Table 6. Summary statistics from three slaughter groups.

	N	Mean		SE	95% CI
MARC Group					
Lung Lesion +	26	MDG	2.91	0.353	2.84 - 2.99
		HCW	735	10.57	713 - 756
		Yield	2.65	0.095	2.46 - 2.85
		Grade	Cho	------	Cho
Lung Lesion -	52	MDG	2.99	0.0451	2.91 - 3.09
		HCW	740	8.49	723 - 757
		Yield	2.58	0.069	2.43 - 2.72
		Grade	Cho	------	Cho
Group 1					
Lung Lesion +	80	MDG	2.87	0.11	2.87 - 3.29
		HCW	713	6.84	700 - 727
		Yield	2.43	0.064	2.31 - 2.56
		Grade	Cho	------	Cho
Lung Lesion -	32	MDG	3.74	0.14	3.46 - 4.03
		HCW	784	12.9	758 - 811
		Yield	2.63	0.098	2.43 - 2.83
		Grade	Cho	------	Cho
Group 2					
Lung Lesion +	89	MDG	3.89	0.082	3.73 - 4.06
		HCW	800	7.74	785 - 816
		Yield	2.16	0.092	1.97 - 2.34
		Grade	Sel	------	Sel - Cho
Lung Lesion -	139	MDG	3.93	0.071	3.79 - 4.07
		HCW	815	5.86	804 - 827
		Yield	2.32	0.072	2.17 - 2.46
		Grade	Sel	------	Sel - Cho

Quality grades: Choice = Cho, Select = Sel

was collected on 162 MARC calves, 225 group 1 calves, and 355 group 2 calves. Eighty-six calves were excluded from the MARC data, 113 from group 1 and 127 from group 2. Explanations for these exclusions are reported and tabulated in Table 7.

Table 7. Calves excluded from their respective slaughter groups and the reasons for exclusion.

	Missing Entry Weights	Missed Viscera Table Observations	Frame Shift	Not Graded	Lost Identifications
MARC Group	2	7	75	2	0
Group 1	15	69	0	0	29
Group 2	2	125	0	0	0

The objectives of this project are to produce a standardized method for scoring lung lesions at slaughter and investigate the effects of the processes producing these lesions on calf growth and carcass traits. Several populations of cattle identified pre-slaughter were thought to have sufficient data to allow these investigations. Problems such as missing weights, non readable identifications, cattle slaughtered without notification, and identification frame shifts in the packing plants, have reduced approximately 2,434 head to what is re-

ported here.

Pneumonia may produce gross lesions persisting to slaughter. These lesions can be identified at slaughter and associated with differences in calf growth and carcass traits. Numerically, animals in this study with lesions at slaughter have decreased MDG, lower hot carcass weights, and variable effects on yield grades and quality grades.

References

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Abstract

The effects of induced parturition in dairy cows on the incidence of mortality in calves from commercial herds in south-western Victoria

J.M. Morton* and K.L. Butler†

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The effects of induced parturition on calf morality rates were studied in 24 winter-calving, pasture-fed, dairy herds in south-western Victoria. Parturition was induced when most cows were between 27 and 35 weeks of pregnancy. Control groups were selected from cows in the same herds in which calving was not induced. The incidence of mortality within 7 days of birth was much higher among calves form cows in induced groups relative to those in control groups (estimated median herd mortality incidence 72% and 7%, respectively). The incidence of calf mortality was high among groups induced at all stages of pregnancy that were investigated. However, differences in calf mortality incidence, relative to controls, were increased among groups induced at earlier stages of pregnancy.

* Department of Agriculture, 78 Henna St, Warrnambool, Victoria 3280

†c/- Victorian Institute of Animal Science, Sneydes Road, Werribee, Victoria 3030