A Retrospective Investigation and Random Sample Survey of Acute Bovine Pulmonary Emphysema in Northern California

Billy R. Heron, *D.V.M., M.P.V.M.*
Dan E. Suther, *D.V.M., M.P.V.M.*
California Department of Food and Agriculture, Bureau of Animal Health
2135 Akard Avenue, Redding, California 96001.

Summary

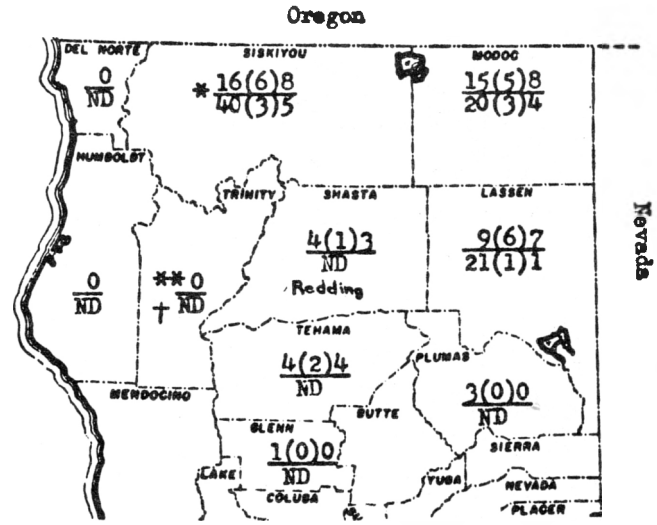
A retrospective investigation (RI) of Acute Bovine Pulmonary Emphysema (ABPE) involved 14 veterinarians, 20 premises, and 30 occurrences of the disease in 10 Northern California counties. There were 9,851 cattle at risk in the investigation, and 6,046 of these were adults. The adult mortality rate was 2.61%. Attack rates and case fatality rates were variable; but in general, inversely related. Calves were not significantly affected. Cases were noted in all months except February and December.

A statistically designed random sample survey (RS) was conducted on 81 premises in three of the counties. Equivalent mortality rates were found in the RI and the RS for each class of cattle. Sex differences were not statistically significant. Type of forage management was found to be significant ($p < .005$) to the occurrence of ABPE. The incidence of ABPE was estimated at 594 adult cases with 121 deaths out of 90,688 cattle in Lassen, Modoc, and Siskiyou counties. The total estimated economic costs for ABPE in these three counties was $127,550.00 in 1973.

Introduction

Acute Bovine Pulmonary Emphysema (ABPE) has been referred to as Atypical Interstitial Pneumonia,[2] Acute "Typical" Interstitial Pneumonia,[7] Interstitial Pulmonary Emphysema and Edema,[10] and Fog Fever. [18, 20]

These and other synonyms for ABPE have been adequately listed by other authors,[11, 15] and the history of this disease from 1830 in Europe,[11] Canada since 1924,[21] and the U.S. from 1940,[11] has also been delineated. In the past, the syndromes referred to in the literature as ABPE have included conditions now known to be caused by certain specific factors[18, 21, 23] and are disease entities that are separate and distinct from classical ABPE. The causal factors of classical ABPE have not been clearly and irrefutably defined; therefore, a description of the epizootiology, signs, and pathology of the disease under study is necessary.



* A(B)C - Retrospective Investigation
D(E)F - Random Sample Survey

A	Reported by veterinarians - Total	52
(B)	Premises investigated "	20
C	Occurrences of ABPE "	30
D	Premises in survey "	81
(E)	Premises with ABPE "	7
F	Occurrences of ABPE "	10

** No occurrences reported. † = Not done.

Fig. 1. Distribution of Acute Bovine Pulmonary Emphysema in 10 counties of Northern California. Shows, by county, numbers of premises referred (Retrospective Investigations, 1963-1973) or sample size (Random Sample survey, 1970-1973), numbers of premises with history of ABPE and numbers of separate occurrences.

© Copyright American Association of Bovine Practitioners; open access distribution.

Classical ABPE is usually thought to be associated with some change in feed, usually from dry, sparse, overgrazed pastures to lush pastures with an abundance of new growth. The etiology is not known, but several reports[3, 4, 5, 6, 25] indicate the possibility of the involvement of metabolites of certain amino acids (especially tryptophan), which are in high concentration in the young regrowth portions of pasture plants.[19]

Severely affected cattle are reluctant to move, often have a "saw-horse" stance with head lowered and neck extended. They have increased and shallow respiration and may display a characteristic expiratory grunt. Occasionally, subcutaneous emphysema may be noted in the cervical area and dorsal thorax.

On post-mortem examination, the lungs are distended; and due to the obvious interstitial emphysema, do not collapse when the thorax is opened.

The literature indicates a high incidence in the Western United States. Studies attempting to determine causes have been conducted using herds in California.[16, 17] To our knowledge, no study has been conducted to assess the incidence of ABPE in Northern California or to estimate its cost to the cattle industry.

Our investigation used two techniques: (1) a retrospective investigation (RI) of occurrences brought to our attention by veterinarians engaged in food animal practice, and (2) a random sample survey (RS) of herds in an area of Northern California where ABPE is known to occur.

The purposes of this study were: (1) to determine the incidence of APBE; (2) to evaluate forage-management practices as they relate to the occurrence of ABPE; (3) to accumulate date in order to derive overall and specific attack rates (AR),a/ mortality rates (MR),b/ and case fatality rates (CFR);c/ (4) to observe geographical and seasonal occurrences of ABPE; and (5) to estimate the economic impact of the disease.

For clarity, case is defined as one animal affected with ABPE and occurrence is defined as one event in which one or more cases were diagnosed in the same herd.

Materials and Methods

Retrospective Investigations

Interview of Veterinarians

Interviews were conducted with 16 veterinarians, engaged in food-animal medicine whose practices covered the 10 northernmost countries of California. (Fig. 1.) They were queried about their past experience with ABPE, with particular reference to identification of premises where the disease had occured. The year(s) ABPE had been seen, post-mortemfindings, treatment and results, morbidity and mortality estimates were also sought.

Premises Investigations

Thirty ranches which were known or suspected to have had ABPE by the interviewed veterinarians were investigated by personnel of either the California Bureau of Animal Health or USDA, APHIS, Veterinary Services. These investigations required two to three hours interviewing the ranch owner or manager and observing the premises. Information collected included: (1) Ranch Description - acreage, elevation, forage types, crops, fertilization and irrigation practices; (2) Cattle Description - age, sex, breed, breeding dates, dates of purchase, and changes in herd composition; (3) Normal Movement Pattern - dates, distance moved, trucked or driven, elevations, pasture type, co-mingling, and length of time this pattern had been in effect; (4) Disease Description - date first seen, how diagnosed, signs, preventive measures, treatments and results, realtionship to other diseases, economic evaluation, case histories, and feed histories.

No attempt was made to provide a control group for these investigations.

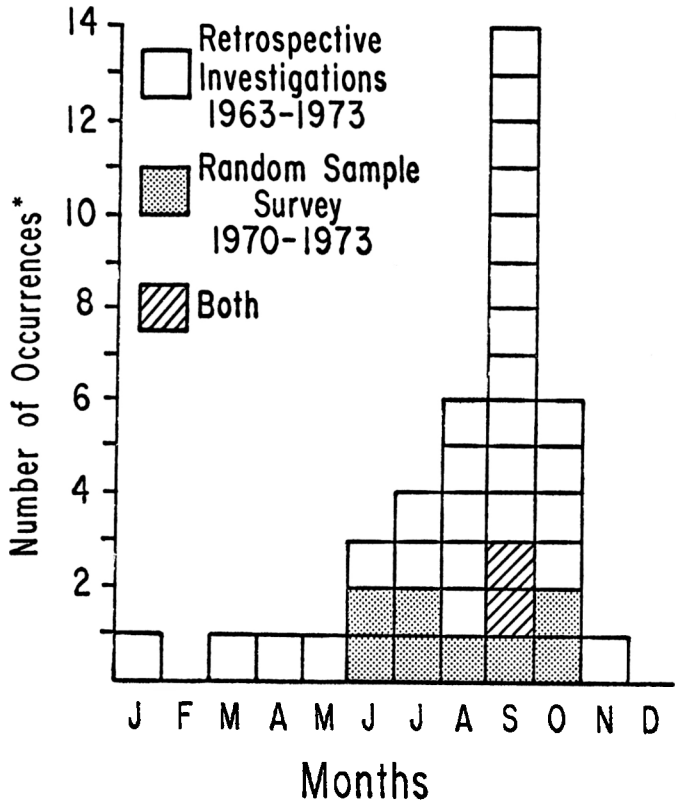


Fig. 2. Monthly distribution of occurrences of Acute Bovine Pulmoanry Emphysema in Northern California. Shows occurrences discovered through Retrospective Investigations (1963-1973), Random Sample survey (1970-1973) or both.

*An event in which one or more cases of ABPE were diagnosed in the same herd.

a/ AR = Number of Cattle with ABPE x 100
Total Cattle at Risk

b/ MR = Number of Cattle Dying with ABPE x 100
Total Cattle at Risk

c/ CFR = Number of Cattle Dying with ABPE x 100
Number of Cattle with ABPE

© Copyright American Association of Bovine Practitioners; open access distribution.

Random Sample Survey

Sampling Procedure

A sample of the 1,213 herds, located in three counties (Siskiyou, Modoc, and Lassen), was taken from the files of the California Bureau of Animal Health Office in Redding. The herds were stratified by county and by herd types. Herds were classified as follows: Stratum I included commercial dairies, commercial and purebred beef herds; Stratum II consisted of all other herd types. Stratum I was sampled at a ratio of 1 to 10 and Stratum II at a ratio of 1 to 20. Commercial and purebred beef herds made up 96% of Stratum I. Mixed beef and dairy and calf raising operations made up 92% of Stratum II. Randomization was obtained by use of a table of random numbers.

Interviews

Interviewees were questioned regarding the occurrences of ABPE during 1973; occurrences at any time in the past (reliability was assumed only as far as the 1970 season); forage management practices and the use of specific preventive measures for ABPE. Information was gathered about animals at risk, morbidity, mortality, times of occurence, movements, the affected group, specific treatment practices and costs.

Results

Retrospective Investigations

Interviews of Veterinarians

Fourteen of the 16 veterinarians interviewed had seen ABPE in their present practice areas. ABPE had occured in 7 of the 10 counties within the last 10 years. In two counties, Siskiyou and Tehama, it had been seen as early as 1950. It was noted in Lassen County in 1951 and in Modoc County in 1956.

Veterinarians reported that necropsies revealed few lesions other than interstitial emphysema and edema. All lobes of the lungs were usually reported to be involved. Pulmonary edema was nearly always present.

Veterinarians estimated the usual AR to be from 3 to 20%, but was occasionally as high as 50%. The mean of the estimates was 6.83%. Estimates of CFR ranged from 3% to 100% with a mean of 49.2%. The mean MR estimate made by veterinarians interviewed was 2.83%.

Treatments reported were antihistamines by 75% of the veterinarians, antiinflammatory drugs (cortisone, dexamethasone) by 65%, and cardiovascular agents (aminophylline, atropine, epinephrine) by 50%. Oxytetracycline [d/] had been used by 75%, but its use had been abandoned because results were equivocal and its use seemed to lack rationale. Subjective evaluations of the efficacy of the treatments varied greatly, but over 85% of the veterinarians rated their treatments between fair and poor.

Fifty-two premises were referred by the veterinarians interviewed and contacts were made with the owners or managers of 30 premises.

Premises Investigations

Of the 30 ranches initially contacted, 10 were no longer in business, or the owners could not remember having had the disease in their cattle. The 20 ranches, 1 dairy, 1 purebred beef herd, and 18 commercial beef herds, which were investigated revealed 30 verifiable occurrences of ABPE. The occurrences could be documented by some or all of the following factors: dates, number and class of cattle at risk, numbers of ill and dead cattle, pasture management, and treatment.

We found ABPE had occurred during every month of the year except February and December. The greatest frequency, 13, was in September, while August and October had 5 and 4 occurrences respectively (Fig. 2).

The geographical distribution by county revealed Lassen, Modoc, and Siskiyou counties to have 76.7% of the occurrences and 85% of the involved premises (Fig. 1). Although ABPE tended to occur at higher elevations, no conclusions can be drawn from this data because the distribution by elevation of the total premises in the study area is known.

The disease appeared with a variety of pasture management patterns. Nineteen occurrences (63.3%) resulted from the movement of cattle from summer ranges to aftermath (regrowth) hay fields. Movement from one irrigated field to another on the same ranch accounted for 6 occurrences (20.0%). One occurred in cattle reportedly not moved, 1 in dairy cows being fed hay, 2 in cattle moved from mountain range to dryland pasture, and 1 when changing feed from coarse hay to pasture.

The forage most frequently involved was native meadow grasses, with twelve occurrences (40.0%). Improved meadows with a mixture of grasses (fescue, rye grass, Dallis grass, etc.) and legumes (trefoil and clovers) were next with 9 occurrences (30.0%). Four occurrences (13.3%) were on alfalfa pasture, 2 on lush spring range, 2 on dry native grasses and 1 on hay.

The interval between movement to new feed and observation of signs of the disease ranged from 4 to 14 days with a mean of 8.4 days. Signs of ABPE most noticed by ranch operators were panting, reluctance to move, tongue extended, and coughing (Table 1).

Total cattle at risk (i.e., those on pastures with cattle having ABPE) were 9,851. Cattle identified as having ABPE were 292 cows, 6 bulls, 4 yearlings, and 1 calf. The overall attack rate was 3.08%. Deaths were reported in 153 cows, 5 bulls, 4 yearlings, and 1 calf. The overall mortality rate was 1.65%. The adult AR was 4.93%. While the adult female AR was 5.01% and the adult male AR was 2.78%, this difference was not statistically significant (P .10 by x^2 test). Only 1 calf was reported to have had the disease, AR = 0.028%. This rate does not differ significantly from the hypothesis that calves

d/ Liquamycin, Pfizer, Inc., New York, N.Y.

© Copyright American Association of Bovine Practitioners; open access distribution.

do not get ABPE (P = .68 by Z test). The yearling AR of 1.75% was significantly different from adult AR (P 0.05 by X^2 test). The adult MR was 2.61% and the adults CFR was 53.02% (Table 2). The reported AR and CFR were extremely variable, but as a rule the higher the AR the lower the CFR.

No breed specific rate differences could be demonstrated.

Preventive measures had been instituted on some premises since previous occurrences of ABPE. The most common practice was to feed hay or dry pasture to adult cattle prior to turning them into green pasture. This was usually accompanied by feeding hay in the field or in a corral each morning for 3 to 7 days. The second most common preventive measure was to graze yearlings on the pasture for 14 to 30 days prior to turning cows into these pastures. Other practices included waiting for a hard frost, stopping irrigation early and letting the forage mature, and cutting the regrowth 3 to 7 days prior to making the fields accessible to adult cattle. Twelve of the 20 premises used no preventive measures.

Our investigations indicated a weight loss of affected cows estimated to be between 45.5-90.9 kg (100-200 pounds) per head. Costs of preventive measures include: lowered weight gain in calves when they and their dams receive lower quality roughage rather than lush pasture; cost of hay and labor of feeding; loss of quality of pastures when frosted or overly mature; and labor cost of handling cattle.

Random Sample Survey

Eighty-one of the 93 selected premises were surveyed. The results were analyzed correlating herd type with the incidence of ABPE in the 4 years from 1970-1973. No occurrence of ABPE was found in herds of Stratum II. In the 68 herds of Stratum I, we found 7 ranches with a total of 10 occurrences during those years. Nine occurrences of ABPE were found in commerical beef herds and 1 in a purebred beef herd. An analysis of 3 herds and 5 occurrences prior to 1973 was not done due to incomplete data. Four herds (4.94%) of the 81 in the sample had 5 occurrences during 1973, with 390 cows, 299 calves at side, 39 heifers, and 17 bulls at risk. Fifty-nine of these were affected, AR = 7.92%, and 12 died, CFR = 20.34%. The attack rate varied from 2.0% to 38.5%. Cows, bulls, and heifers (18 months old) all showed illness and death with ABPE, but none of the calves were affected. The adult MR was 2.70% (Table 2). There was one occurrence of the disease each month from June through October (Fig. 1).

We found that ranches in Stratum I followed forage-management practices (FMP) of four basic patterns: (Table 3).

1. Limited or No Movement (LNM) - Twenty-six ranches (38.2%) do not move their cattle to range and have either a single pasture or a very limited movement pattern in which the cattle are moved to pastures that have been left ungrazed less than two weeks.

2. Home Ranch Rotation (HRR) - Twelve ranches (17.6%) maintain their cattle on the home ranch but follow a pattern of pasture rotation in which pastures are irrigated and rested longer than 2 weeks, but less than 10 weeks.

3. Range to Home Ranch with Preventive Measures (RHPM) - Eighteen ranches (26.5%) move their cattle to summer range in April, May or June and then return them to the home ranch between July and November, but in the process of returning their cattle to cutover hay fields and other home pastures, they follow practices that possibly help prevent ABPE. Examples of these practices were: (a) putting the cattle on cutover hay fields immediately (usually 1 to 3 days) after the last cutting of hay had been removed; (b) feeding the cattle dry hay before putting them on new fields, or pasturing them on abundant mature forage for 1 to 2 weeks prior to exposure to lush pastures; (c) putting them on pastures that had 10 to 14 weeks of summer and fall growth; or (d) returning the cattle to home pastures very late in the fall after a severe frost has occurred. Some of these measures were initiated for bloat prevention, others simply because of the availability of mature pastures or the timing of the last cutting of hay and the closing dates on summer range. Only two ranchers in our sample were using planned preventive measures against ABPE. One with 38 deaths (19.5% adult MR) in 1971 instituted preventive measures subsequently and had no occurrence in 1972 or 1973. Annual preventive costs were $15.00 per adult. The other with two occurrences in 1973 applied preventive measures at a cost of $3.50 per head to the specific pasture and specific group of cattle involved in the first occurrence in September (adult MR of 10.5%). No further problems occurred in these cattle. In October, the ranch had another attack with different cattle on a different pasture where no preventive measures had been applied. These two ranches were given partial value in RHPM and RHNP (Table 3) for the time and portion of each ranch with these FMP's.

4. Range to Home Ranch with No Preventive Measures (RHNP) twelve ranches (17.6%) move their cattle to summer range and return them to home pastures without the benefit of either planned or unplanned preventive measures.

No occurrences of ABPE were found in either the LNM group or the RHPM, although these ranches made up 65% of Stratum I. Together with herds of Stratum II, which closely resemble LNM in management, they constitute 70% of the total sample. Ranches that return from range without preventive measures (RHNP) had 3 herds (23.1%) with 4 occurrences of ABPE during the years 1970 through 1973. The HRR group had 4 herds (33.3%) with 6 occurrences of the disease.

The difference between the incidence of verified occurrences of ABPE according to forage management practices is highly significant, P .005 (Table 3).

Three of the 5 outbreaks in 1973 occurred on premises that had ABPE previously, but ownership had changed during the last year. One occurrence was on a ranch that had

© Copyright American Association of Bovine Practitioners; open access distribution.

Table 1 - Signs of ABPE Reported by Ranch Operators in the Retrospective Investigations (1963-1973) in Northern California. Listed in Order of Increasing Severity.

	Frequency Reported
Not Eating	4
Pinched Nostril	3
Coughing	4
Reluctant to Move	7
Panting (Mouth Breathing)	15
Tongue Extended	5
Wheeze or Rattle	4
Expiratory Grunt	2
Found Dead	3

never had ABPE and one on a ranch that had the problem every year.

The owners of four ranches where ABPE had been verified also felt that they had had 1 to 3 cases annually, and 4 additional herds of HRR and RHNP types reported diseases similar to ABPE that could not be verified.

Pastures involved in the 1973 occurrences contained a variety of forage types. Fescue, clovers, timothy, rye grass, orchard grass, and various native grasses were growing in these pastures. Alfalfa was not in any of the pastures where cases occurred in the RS survey.

Costs of the disease were ascertained from the following information. We found that 8.3% of the cattle were at risk.

Table 2 - Overall, Age and Sex Specific Attack Rates (AR), Mortality Rates (MR), and Case Fatality (CFR) for the Retrospective Investigation (1963-1973) and the Random Survey (1970-1973) ABPE studies in Northern California, with Chi-square (X^2) Probabilities for Equivalence Between MR Groups.

Rates		Retrospective		Random Sample		X^2 Probabilities
Overall	AR	303/9851 =	3.08%	59/745 =	7.92%	
	MR	163/9851 =	1.65%	12/745 =	1.61%	P>0.70
	CFR	163/303 =	53.80%	12/59 =	20.34%	
Adult	AR	298/6046 =	4.93%	53/407 =	13.02%	
	MR	158/6046 =	2.61%	11/407 =	2.70%	P>0.70
	CFR	158/298 =	53.02%	11/53 =	20.75%	
Adult Male	AR	6/216 =	2.78%	1/17 =	5.88%	
	MR	5/216 =	2.31%	1/17 =	5.88%	P>0.60
	CFR	5/6 =	83.33%	1/1 =	100.0%	
Adult Female	AR	292/5830 =	5.01%	52/390 =	13.33%	
	MR	153/5830 =	2.62%	10/390 =	2.56%	P>0.70
	CFR	153/292 =	52.40%	10/52 =	19.88%	
Yearling	AR	4/229 =	1.75%	6/39 =	15.38%	
	MR	4/229 =	1.75%	1/39 =	2.56%	P>0.70
	CFR	4/4 =	100.00%	1/6 =	16.67%	
Calf	AR	1/3576 =	0.028%	0/299 =	0.0%	
	MR	1/3576 =	0.028%	0/299 =	0.0%	P>0.60
	CFR	1/1 =	100.0%	0/0 =	0.0%	

© Copyright American Association of Bovine Practitioners; open access distribution.

Of the adult animals at risk, 13% were affected and 20.8% of the affected animals died. Of the affected survivors, 34% were severely affected with marked weight loss and debilitation; 28% required treatment at an average cost of $16.00 per head. Approximately 66% of the affected animals suffered weight losses between 45.5 and 90.0 kg (100-200 lbs.).

Discussion

As previously reported in Utah,[1] Texas,[10] California,[17] and other western states,[12,24] the classical occurrence of ABPE as seen in the U.S. is thought to follow the movements of cattle from the dry, coarse, scabrous range feed to lush pastures of meadows or cutover hay fields. This type of forage management practice would correspond to the pattern designated as RHNP in our RS survey. The RS survey revealed that 23.1% of the ranches with this type of FMP had experienced an average of 1.33 occurrences during the last 4 years. Parelleling this finding, the RI indicated that 63.3% of the occurrences had been associated with movement of cattle from summer ranges to aftermath hay fields.

To our knowledge, the literature seldom indicates an association of ABPE occurrence with pasture rotation forage management in the U.S., although there is an occasional mention of sporadic summer cases.[1] This type of FMP, or a similar pattern, apparently causes difficulty in Mid-Wales.[21] The RS survey indicated 33.3% of the ranches with this management had had an average of 1.5 occurrences from 1970-73. Twenty-five percent had occurrences in 1973. In the RI study, the second highest group (with 20% of the occurrences) was associated with movement from one irrigated pasture to another. It is interesting to speculate why ABPE is rarely reported in lowelevation valleys such as the Sacramento and San Joaquin where this FMP is common.

It appears that forage management plays a role in the occurrence of ABPE in that the practices designated LNM and RHPM showed no occurrences of ABPE in the RS survey. The differences between the incidences in these classes and the HRR and RHNP are highly significant (P<.005).

Within the classes of FMP with ABPE (HRR and RHNP), a relationship of attack rate and mortality rate to forage management is suggested. The occurrences detected by RS survey for 1973 had an overall AR for HRR herds of 2.7%, and MR of 1.0%, whereas the RHNP herds had overall AR and MR of 27.0% and 3.8% respectively. The difference is significant for both AR (P<.0005) and MR (P<.025). This would tend to reinforce the assumption of the workers in mid-Wales[20] that the "classical" American occurrence of ABPE (with RHNP management) shows high AR contrasted to the British experience (with FMP similar to HRR) of low AR where 85% of occurrences involved single animals.

In the RI, the much greater number of occurrences (63%) in RHNP-type herds compared to the lower number (20%) in HRR-type herds is probably due to spectacular epizootics being easier to remember than sporadic cases.

In our calculations, we have assumed all calves, regardless

Table 3 - Distribution of Herds and Occurrences of ABPE by Forage Management Practices, 1970-1973 Random Sample Survey, Modoc, Lassen and Siskiyou Counties, California.

Strata Forage Management Practice*	Number of Affected Herds (Occurrences)**					Sampled
	1973	1972	1971	1970	Total	
Stratum I						
LNM	0	0	0	0	0	26
HRR	3 (3)	2 (2)	0	1 (1)	4 (6)+	12
RHPM	0	0	0	0	0	18
RHNP	1 (2)	0	2 (2)	0	3 (4)	12
Subtotals	4 (5)	2 (2)	2 (2)	1 (1)	7 (10)	68
Stratum II	0	0	0	0	0	13
Totals	4 (5)	2 (2)	2 (2)	1 (1)	7 (10)	81

*Stratum I = Commercial and purebred beef and diary herds.
FMP: LNM = Limited or No Movement, HRR = Home Ranch Rotation, RHPM = Range to Home Ranch With Preventive Measures, RHNP = Range to Home
Ranch With No Preventive Measures.
Stratum II = All other herd types. FMP: Most closely resembles LNM.

**Some herds had more than one occurrence.

+Row totals are less than expected due to some herds having occurrences in more than one year. Chi-square = 17.8763, 4 df. P .005.

© Copyright American Association of Bovine Practitioners; open access distribution.

of age, to be at risk. However, our results confirm the assumption that calves at side (i.e. nursing) are not susceptible.[10,17,20] The RI study revealed one calf that reportedly died of ABPE, but the case was not confirmed by post-mortem examination nor diagnosed by a veterinarian. With exception of experimental work,[8] we know of no reports of ABPE in calves that have been confirmed pathologically.

Observed AR are a function of the skill of the observer as well as his memory; CFR are computed using AR. The MR which are based on hard facts which cannot be ignored nor easily forgotten are, therefore, our most reliable rates.

There is a lower AR in yearlings than in adults in the RI. It is possible that this difference is an artifact; however, support for a difference in susceptibility is found in the practice of grazing yearlings on particular pastures known to produce ABPE in adult cattle.

Estimates of economic losses for Modoc, Lassen, Siskiyou counties can be made by extrapolating the AR and MR rates derived from the RS survey. These three counties have a total adult cattle population of 90,688. Direct extrapolation of the incidence and related rates (with 594 adult cases and 121 deaths estimated) and an extrapolation of the costs of planned preventive measures, treatment and weight losses give a total estimated dollar loss of $127,550.00 for the three counties during 1973. The above estimate is admittedly conservative in that the incidence figures reflect only occurrences that could be confirmed. Suspicious occurrences were not included.

The estimates of annual losses derived from the random sample survey cannot be used to indicate any possible level of loss in the other 7 counties in the retrospective investigation or to the State of California as a whole. The selection of the 3 counties (Modoc, Lassen, and Siskiyou) was biased in favor of finding evidence of occurrences of ABPE. The study indicates, however, that we should look more carefully at other parts of California for evidence of "nonclassical", low attack rate occurrences of ABPE.

Acknowledgements

Appreciation is expressed to the veterinarians engaged in food animal practice and the ranchers in Northern California who cooperated in this study. Special thanks to Dr. John R. Chandler, Mr. W. E. Barnes, and Mr. Fred H. Powers for their assistance; and to Dr. P. L. Smith, Chief, Bureau of Animal Health, and Dr. Carl W. Miller, Staff Epidemiologist, for their encouragement.

References

1. Blake, J. T., and Thomas, D. W.: Acute Bovine Pulmonary Emphysema in Utah. J.A.V.M.A., 158, (June 15, 1971):2047-2052. — 2. Blood, D. C.: Atypical Interstitial Penumonia of Cattle. Canad.Vet.J., 3, (1962):40-47. — 3. Carlson, J. R., Dyer, I. A., and Johnson, R. J.: TryptophanInduced Interstitial Pulmonary Emphysema in Cattle. Am.J.Vet.Res., 29, (Oct. 1968):1938-1939. — 4. Carlson, J. R., Yokoyama, M. T., and Dickinson, E. O.: Tryptophan-Induced Interstitial Pulmonary Emphysema in Cattle II. 3-Methylindole as a Cause of Pulmonary Edema in Cattle and Goats. Science, 176, (1972):298-299. — 5. Dickinson, E. O., Jr.: The Effects of Tryptophan on Bovine Lungs. Diss. Abst.Int., 31B, (1970):3513-3514. — 6. Dickinson, E. O., Spencer, G. R., Gorham, J. R.: Experimental Induction In *Speakers' Syllabi.* 85th Ann. Meeting and Scientific Seminar, 4, Calif.Vet.Med.A. (1973):7-11. — 8. Eyre, P.: Acute Bovine Pulmonary Emphysema. Vet.Rec., 91, (1972):38-40. — 9. Goodman, A. A.: Bovine Asthma. N.Amer.Vet., 37, (1956):850-852. — 10 Jones, L. P.: A Perspective on Interstitial Pulmonary Emphysema and Edema (IPE) of Cattle. Southwestern Vet., 25, (1972):193195. — Maki, L. R.: A Review of the Literature of the History and Occurrence of Bovine Pulmonary Emphysema. Proc. Symp. on Acute Bovine Pulmonary Emphysema, University of Wyoming, Laramite, WY., (1963):1-17. — 12. Maki, L. R., and Tucker, J. O.: Acute Bovine Pulmonary Emphysema. Proc. Symp. on Acute Bovine Pulmonary Emphysema, Univ. of Wyomin, Laramie, WY., (1965):A1-A4. — 13. Maki, L. R., and Tucker, J. O.: Acute Pulmonary Emphysema of Cattle. II. Etiology. Am.J.Vet.Res., 23, (July, 1960):824-826. — 14. Michel, J. F.: A Contribution to the Aetiology of Fog Fever. Vet.Rec., 66, (1954):381-384. — 15. Moore, G. R.: Bovine Asthma. N.Amer.Vet., 33, (1952):418. — 16. Moulton, J. E., Cornelius, C. E., and Osborn, B. I.: Acute Pulmonary Emphysema in Cattle. J.A.V.M.A., 142, (Jan. 15, 1963):133-137. — 17. Moulton, J. E., Harrold, J. B., and Horning, M. A.: Pulmonary Emphysema in Cattle. J.A.V.M.A., 139, (Sept. 15, 1961):669-677. — 18. Pirie, H. M., Dawson, C. O., Breeze, R. G., Selman, I. E., and Wiseman, A.: Fog Fever and Precipitins to Mico-Organisms of Mouldy Hay. Res.Vet.Sci., 12, (1971):586-588. — 19. Rendig, V. V., and McComb, E. A., Department of Soils and Plant Nutrition, University of California, Davis, California: Unpublished data, 1972. — 20. Roberts, H. E. Benson, J. A., and Jones, D. G. H.: "Fog Fever" (Acute Bovine Pulmonary Emphysema) in mid-Wales, 1971: Features of Occurrence. Vet.Rec., 92, (1973):558-561. — 21. Schofield, F. W.: Acute Pulmonary Emphysema of Cattle. J.A.V.M.A., 112, (March, 1948):254-259. — 22. Schwabe, C. W.: Veterinary Medicine and Public Health. 2nd Ed. The Williams and Wilkins Co., Baltimore, MD., 1969. — 23. Spencer, G. R.: Verminous Pulmonary Emphysema. Proc. Symp. on Acute Bovine Pulmonary Emphysema, University of Wyoming, Laramie, WY., (1965):F1-F4. — 24. Tucker, J. O., and Maki, L. R.: Acute Pulmonary Emphysema of Cattle. I. Experimental Production. Am.J.Vet.Res., 23, (July, 1962)S:821823. — 25. Yang, J. N. Y., and Carlson, J. R.: Effects of High Tryptophan Doses and Two Experimental Rations on the Excretion of Urinary Tryptophan Metabolites in Cattle. J.Nutrition, 102, (1972):16551666.

© Copyright American Association of Bovine Practitioners; open access distribution.