MEAT & LIVESTOCK AUSTRALIA

On farm

DISEASES OF FEEDLOT CATTLE

Project DAN.064

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Feedlots

DISEASES OF FEEDLOT CATTLE

WORKING COMMITTEE

This project was planned and supervised by a committee representing all of the organisations involved. The group met at 2-3 month intervals throughout the project for planning and to review progress. Several of these meetings were held at participating feedlots to provide the feedlot managers with an opportunity to attend. Membership of the committee was as follows:

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EXECUTIVE SUMMARY

Objectives

The objectives of this project were to determine the rate and significance of disease and deaths in feedlot cattle (Reported to MRC in a separate Phase 1 report) and, subsequently, the infectious causes of respiratory disease and the causes of death in feedlot cattle in eastern Australia.

Methodology

Six feedlots located in Eastern Australia were selected for participation in a detailed study of the causes of disease and deaths, especially the Bovine Respiratory Disease (BRD) complex. In order to assess possible seasonal variations in disease occurrence, a pen of animals was recruited at each feedlot in each season. These surveillance pens contained a total of 5,306 cattle while during the 18 month study period (October 1991 - March 1993) there were approximately 233,450 cattle on feed in the project feedlots.

Blood samples from sentinel animals were examined for antibodies against the following four viruses - pestivirus (Bovine Viral Diarrhoea Virus or BVDV), bovine herpesvirus 1 (Infectious Bovine Rhinotracheitis or IBR virus), Parainfluenza virus Type 3 (PI3) and Bovine Respiratory Syncitial Virus (RSV) - at entry, after 6 weeks on feed and at slaughter.

Any cattle taken from the surveillance pens for treatment for any illness during the feeding period were sampled and rebled 3 weeks later.

Any cattle that died in the surveillance groups were autopsied and a range of fresh and fixed samples collected.

At slaughter the visceral organs of all cattle in the surveillance groups were examined for abnormalities.

In addition, all cattle deaths in the participating feedlots were recorded and a diagnosis established and, in many cases, full laboratory investigations carried out.

Results

At entry to the feedlot, there were antibodies present (indicating previous infection) against all four of the viruses surveyed. The levels of past infection with the respective viruses on entry of the cattle to the feedlot were: pestivirus 68%; IBR 13%; PI3 57%; RSV 27%.

Of the animals susceptible to infection with pestivirus at entry, it was found that 68% became infected in the first 6 weeks. The comparable rates for the other viruses were: IBR 30%; P13 48%; RSV 57%. At the end of six weeks 9.8% were still susceptible to pestivirus. The comparable rates for the other viruses were: IBR 61%; PI3 22%; RSV 31%. By the time of slaughter, there were 6% of animals still seronegative and therefore susceptible to pestivirus. The rates for the other viruses were: IBR 24%; PI3 22%; RSV 29%.

Disease was diagnosed in 6.8% of animals. Fever at the time of entry to the feedlot and BRD are the most important types of sickness and account for 66% of cases of sickness. Seventy eight per cent of all cases of disease (including fever at entry) were found to occur in the first 4 weeks after entry to the feedlot. Viral infections were identified in 72% of sick animals and several of viruses were implicated. BVDV and IBR virus were found to be significantly associated with cases of BRD while BVDV, IBR and RSV viruses were associated with fever at entry in some feedlots. Bacteria were only cultured from 19% of sick animals. *Pasteurella haemolytica* was cultured much more frequently than *P. multocida* but most isolates were from animals with fever at entry, rather than respiratory disease.

Deaths were reported from 0.9% of animals. It was found that 53% of the deaths investigated were due to BRD. Pestivirus and IBR were isolated with similar frequency. *Pasteurella multocida* was more common than *P. haemolytica*, in autopsy material. Other bacteria commonly isolated were *Salmonellae* and *A. pyogenes.*

The IBR (BHV1) viruses isolated were all found to belong to the same subtype, 1.2, as found in Australia previously.

Conclusions

During the course of the project, the levels of sickness and death were within the range expected from a normal feedlot (ie one not experiencing a major disease problem) and were similar to those reported during the Phase 1 project disease survey.

BRD was still found to be the most frequently diagnosed disease condition in most feedlots. Infections with each of the 4 viruses was common in sick cattle, either individually or in various combinations. The small numbers of sick cattle in most groups limited the capacity to apply an intensive statistical analysis of the relative importance of the 4 viruses studied. However, across all feedlots, IBR infection alone or combined with RSV infection was positively associated with illness due to BRD. When results from individual feedlots were examined, there were also significant associations of BVDV infection with respiratory disease and BVDV, IBR and RSV infections with fever at entry. The frequency and complexity of multiple infections and interactions between both viruses and bacteria and the intensity of sampling in this study limited the ability of this study to identify the role of viruses such as BVDV as predisposing agents to other infections.

The majority (87%) of cattle entering a feedlot were susceptible to IBR virus and 61% of animals were still susceptible after 6 weeks in the feedlot. IBR infections later during the feeding period were not related to the occurrence of respiratory disease during the study period.

Approximately two thirds of cattle entering feedlots are apparently immune to BVDV on entry but there can be still substantial numbers of susceptible cattle in some pens. This virus is readily spread between animals and most of the susceptible animals become infected with pestivirus in the first few weeks in the feedlot, coinciding with the peak of BRD cases.

Feedlot cattle quickly become infected with PI3 and RSV viruses but this does not appear to be associated with disease. There was a wide variation between groups in susceptibility on entry to all 4 viruses and this was not related to age at entry to the feedlot.

There was a wide range between groups in the rate of infection by all 4 viruses both in the first 6 weeks and between 6 weeks and slaughter and this was not restricted to an individual feedlot or related to the number of days animals were on feed.

P haemolytica was cultured more frequently from sick cattle soon after entry to the feedlot than *P. multocida* but most of the isolates come from febrile animals rather than animals with respiratory disease.

BRD was identified as the cause of 53% of deaths. BVDV and IBR were isolated from post mortem material with similar frequency and were both shown to be significantly associated with deaths from respiratory disease. *P multocida* was more common than *P haemolytica*, in autopsy material. Other bacteria commonly isolated were *Salmonella* spp and *A pyogenes.*

The Australian population of Bovine Herpesvirus 1 remains genetically distinct from the pool of viruses in North America and Europe, where a more virulent subtype is frequently found in feedlot cattle. As a consequence of these differences, extreme care should be taken to prevent the introduction of 'exotic' strains of BHV1, either in vaccines or live animals.

When the project animals were examined at slaughter, condemnations due to liver damage occurred with relatively high frequency. Careful sourcing of cattle from liver fluke free country could save the cost of both drenching for liver fluke as well as reducing the number of liver condemnations at slaughter.

Recommendations and Application of Outcome

Respiratory disease and fever at entry appear to be the most common disease problems in feedlot cattle. As most of the illness in these animals occurs in the first 4-6 weeks from the time of entry, control measures need to be effective at the time of entry to the feedlot, or even from the time of departure from the property of origin, when cattle begin to be exposed to a different range of pathogens and stress. As it usually takes animals at least three weeks to develop effective immunity by natural exposure or after vaccination, vaccination on entry to the feedlot will not provide optimal

control of BRD. Vaccines and other control measures will preferably need to be delivered to animals on the property of origin and before mixing with animals of different origins. A sufficient lead-time will be required to provide optimal protection. Measures to assist cattle adapt to the changed environment are also likely to be of benefit. Strategies to provide adequate protection will require changes in both the steer production and feedlot sectors of the beef industry.

DETAILED RESEARCH REPORT

Introduction

In 1991 the Meat Research Corporation commissioned NSW Agriculture to undertake a survey of Australian feedlots to establish the rate and significance of disease and deaths in feedlot cattle. A total of 27 feedlots responded by providing a completed questionnaire summarising the level of disease and death, and in some cases, potential economic loss. Across the industry, the average rates of illness and death were respectively 5.8% and 0.7% of cattle intake. The results of this survey showed that bovine respiratory disease (BRD) was the most important disease entity and cause of death. Full details of this study have been presented to the Corporation as a separate report (Survey of Diseases in Feedlot Cattle, Phase 1 Report). Subsequently, this project was commissioned to undertake a more detailed prospective study of the potential range of agents involved in BRD and the causes of death in Australian feedlot cattle.

Methodology

1. Location of Study

The preliminary survey indicated that there were apparently differences in both the incidence of BRD in different feedlots and that the highest incidence of BRD occurred at different times of the year in different latitudes of Eastern Australia. Therefore, to provide a representative cross-section of the Australian feedlot industry, the study was conducted at six cooperating feedlots, 2 in South-East Queensland, 2 in Northern NSW, 1 in Southern NSW and one in North-West Victoria. Some of the feedlots had been established for many years while others were relatively new.

2. Project Team

Field aspects of the project were coordinated from the Regional Veterinary Laboratories at Toowoomba in Queensland and Armidale and Wagga Wagga in New South Wales through veterinarians consulting to the participating feedlots and also through government veterinary officers. These field based veterinarians usually examined sick animals and conducted autopsies from which specimens were submitted initially to each of the Regional Veterinary Laboratories for pathology and histopathology examinations and bacteriology. Specimens for virology were referred to the Virology Laboratory at Elizabeth Macarthur Agricultural Institute (EMAI), Menangle, NSW for virus isolation and serology. Selected cultures were also sent for specialised bacteriological examinations to the Regional Veterinary Laboratory at EMAI, Menangle, to the Animal Research Institute, Yeerongpilly, Qld and to the Victorian Institute of Animal Sciences, Attwood, Victoria.

3. Selection of Study Groups

As one objective of the project was to define causes of the BRD complex, it was agreed at the outset that it would be acceptable to bias selection of study groups towards those that were believed to be more likely to have a high incidence of respiratory disease. As the risk factors may vary in different environments, the management of each of the participating feedlots was allowed to select the groups of cattle for intensive study. These were referred to as the **surveillance** group, consisting of an entire pen of cattle which entered the feedlot at the same time and were kept together until slaughtered. Because of the possible influence of seasonal and weather conditions on the occurrence of disease, one surveillance group was selected at each feedlot approximately every 3 months, representing spring, summer, autumn and winter.

4. Field Methods and Observations

(a) Observation groups.

During the course of the project, observations were made at the following levels:

Surveillance pen - this was the pen of cattle selected for intensive observation in each feedlot, each season.

Sentinel cattle - within each surveillance pen, at entry twenty randomly selected cattle with normal rectal temperatures (i.e. ≤ 40.5°C) were identified for routine testing for antibodies to the viruses of interest. These animals provided basic data on the proportion of animals infected with various agents at particular times during their movement through the feedlot.

Sick cattle - within each surveillance pen, all sick animals, including animals with a fever (rectal temperature >40.5°C), were identified for clinical examination and sampling. Sick animals were also examined from other pens in the general feedlot population when resources allowed, especially when there was a high incidence of BRD or an unusual disease occurrence.

Dead cattle - all deaths in the feedlots were investigated. Different intensities of investigation were undertaken depending on whether the cattle were in a surveillance pen or elsewhere in the feedlot (see below).

(b) Data collection.

Information was collected on the origin, age, weight and breed of all cattle in surveillance pens, together with data on environmental conditions, length of time that animals were transported, and whether they were obtained directly from the property of origin or through a saleyard. Data collection sheets were designed to ensure standard information was collected (see Appendices 1A-1C).

(c) Examinations, observations and specimen collection.

(i) Surveillance pen - At entry, apart from the feedlot's normal induction procedures (eartagging, weighing, vaccination, drenching, administration of growth promotants etc), rectal temperatures were taken for all cattle in the surveillance group.

(ii) Sentinel cattle - Blood samples were taken from the 20 normal animals which were randomly selected as sentinels at entry and again 6 weeks later.

(iii) Sick cattle - Animals with an elevated temperature (>40.5°C) at entry were sampled. These cattle are subsequently referred to as animals with a fever on entry. Samples collected included blood for serology, ocular and nasal swabs for bacteriology and virology and a faecal sample for bacteriology. Blood samples were again collected 3 weeks later for convalescent viral serology. The same range of samples was also collected from other cattle that were removed from the surveillance pen for treatment for any illness during the feeding period. Sick animals in other pens in the feedlot were occasionally sampled if there was an unusual or severe disease occurrence.

(iv) Dead Cattle - Any cattle that died were examined post-mortem. These investigations were carried out to varying levels of intensity, ranging from a complete autopsy in the surveillance pens together with collection of samples for extensive laboratory examinations to a brief autopsy on cattle in the general feedlot population to establish the broad disease category (eg pneumonia, enteritis etc). The latter are referred to as general feedlot deaths to distinguish them from deaths of surveillance cattle. In the surveillance groups a range of fresh and fixed samples were collected at autopsy. Bacteriology and virus isolation was carried out on fresh samples while formalin fixed samples were submitted for histopathology examinations.

(v) Emergency Slaughter - from time to time, animals suspected of developing disease were sent for immediate slaughter, especially where there was an abattoir nearby. This action was taken by the feedlot management to minimise losses due to disease, the cost of treatment and delays from antibiotic with-holding periods on animals nearing finishing. Where possible, a post-mortem examination was carried out on these animals at the abattoir and samples collected as described previously.

(vi) Abattoir Examinations - An attempt was made to examine all animals from the surveillance pens at slaughter. Blood samples were collected from the 20 sentinel animals and all sick animals (whether those animals were identified as having had a high temperature at entry or becoming sick throughout the surveillance period). In some cases, blood samples were collected from all animals from the surveillance pen. Visceral organs of all cattle in the surveillance group were examined for lesions and the lesions graded and recorded.

(d) Transport and Storage of Specimens

Generally, specimens were transported directly from the feedlot to the supervising Regional Veterinary Laboratory for preliminary processing and examination. Swabs from sick or dead animals were collected into both bacteriological and viral transport medium and fresh tissues into sterile containers. Blood samples for serology and pestivirus antigen detection were collected into plain evacuated glass tubes. All of these fresh specimens were transported chilled and held at $4^{o}C$ until examined. Tissues for histopathology were collected into neutral buffered formalin. All routine bacteriology and histopathology was conducted at the Regional Veterinary Laboratory. Specimens for virus isolation, pestivirus antigen detection and viral serology were referred to the Virology Laboratory at EMAI.

5. Laboratory Methods

(a) Bacteriology

Nasal and conjunctival swabs were collected from sick animals in surveillance pens. Swabs were placed suitable bacteriological transport medium for shipment to the laboratory. A faecal sample was collected *per rectum* from each sick animal and placed in a sterile container. Samples of lung, bronchial lymph node, small intestinal content, mesenteric lymph node and liver were routinely collected and submitted as fresh tissue or swabs of these organs were collected aseptically and placed in transport medium.

Samples for bacteriology were cultured directly onto 5% sheep blood agar plates and/or broth. Selective or enriched media were also inoculated for Salmonellae (XLD, MacConkey's, Brilliant Green) and Pasteurellae/Haemophilus. All plates were incubated aerobically at $37^{o}C$ except those for Haemophilus which were incubated in an atmosphere with 10% CO_2 After 24-48 hours incubation, suggestive primary colonies were identified on the basis of physical characteristics and by the use of appropriate biochemical and serological tests on pure sub-cultures. Salmonella isolates were referred to the Australian Reference Laboratory in Adelaide for speciation. Where possible, Pasteurella isolates were freeze dried for future research.

A subset of isolates of *Pasteurellae (haemolytica and multocida)*

were referred to Dr P. Blackall, ARI, Yeerongpilly, Qld for confirmatory phenotyping and genotyping. Isolates of *P. multocida* were referred to Dr P. Widders (VIAS, Attwood, Vic) for serotyping. The methodology used for the genotyping is described in a separate report to MRC ("Phenotype and Genotype Characterisation of isolates from DAN 064", N. Fegan and P.J. Blackall, September 1994).

(b) Histopathology

Lung, bronchial lymph node, small intestine, mesenteric lymph node and liver were routinely collected from dead cattle in surveillance groups. A range of other tissues were collected from these cattle and from autopsies of animals from the general feedlot population depending upon the gross pathology or clinical signs and history. All tissues were fixed immediately in 10% neutral buffered formalin. Tissues for microscopic examination were routinely processed, embedded in paraffin, sectioned at 5 microns and then stained with haematoxylin and eosin.

(c) Virology

In this project, there was a deliberate focus on four viruses, Infectious Bovine Rhinotracheitis virus (IBR or Bovine Herpesvirus 1), pestivirus (BVDV), Parainfluenza virus 3 (PI3) and Respiratory Syncitial Virus (RSV). These viruses were studied intensively because of their apparent involvement in the BRD complex in other countries. Either virus neutralisation tests (BVDV and IBR virus) or Enzyme Linked Immunosorbant Assays (ELISA for PI3 and RSV) were used to detect antibodies to these viruses. An antigen ELISA was used to detect antigen to BVDV in blood samples and tissues. Virus isolation in bovine testis cell cultures was used to isolate viruses from swabs and tissue samples. These cell cultures were screened by immunoperoxidase staining with monoclonal antibodies to detect BVDV and haemadsorption to detect PI3 virus. The isolation of RSV and IBR viruses was identified by the presence of cytopathology in the cell culture monolayer and the identity of viruses isolated was confirmed by immunofluorescence with specific polyclonal antiserum.

RESULTS

1. Experimental Cattle

The first group of surveillance cattle were inducted in October 1991 with the final group being inducted in March 1993. In all there were 25 groups of surveillance cattle. Five of the 6 feedlots inducted 4 groups of cattle with 20 sentinels in each, while 1 feedlot inducted 5 groups, as one group was inadvertently slaughtered without notification, preventing final examination and sampling.

A detailed account of the animals contained in each of the 25 surveillance pens is contained in Appendix 2. Ten surveillance groups moved directly from their property of origin, 10 groups had animals of mixed origins consisting of direct delivery and saleyards sourced cattle, with 5 groups being solely saleyards derived.

Nineteen of the surveillance groups were British Breed cattle, four were predominantly British Breed with some European/British crossbreeds and 2 were British/Bos indicus cross. The Bos indicus cattle were located in only 1 of the 6 feedlots.

The average ages of the surveillance cattle at entry varied from 12 to 27 months.

There were 5306 cattle in the 25 surveillance groups. The number of cattle making up any one surveillance group ranged from 100 to 389 animals. In 24 of the surveillance groups all the animals were steers and in 1 surveillance group there were both steers and heifers. The average weights ranged from 146 kg to 469 kg on entry to the feedlot. None of the cattle had been subjected to any specific preconditioning or treatment before entry to the feedlot.

2. Surveillance Groups.

(a) Treatments on Entry to the Feedlot

At entry to the feedlot all animals are subjected to a variety of management procedures (known as "induction" treatments), including eartagging, weighing, vaccination, drenching and other treatments which vary within the industry from feedlot to feedlot.

All cattle in the surveillance groups for this project had their rectal temperatures recorded at entry and animals with temperatures greater than 40.5°C were regarded as febrile. The investigation of these febrile animals is described in Section 5(ai).

Sixteen of the 25 groups were treated for roundworms on entry with a Benzimidazole drench and 15 of the 25 treated for liver fluke (13 ex 15 with Fasinex ®). Thirteen of the 25 pens were treated for lice with a range of products. All groups were vaccinated with a "5 in 1" vaccine for protection against clostridial diseases. None of the groups routinely received antibiotics on entry. Seventeen out of 25 groups were implanted with growth promotants and 9 of the 17 were implanted with two promotants simultaneously. Twenty one of the 25 groups received injections for supplementation of vitamins A,D and E on entry, while 20 of the 25 groups also received other supplementary vitamins at entry. Only 4 out of the 25 groups routinely received antibiotics (Oxytetracyline) in their feed and 8 groups were fed a growth promotant (Rumensin ®).

(b) Production Parameters for Surveillance Cattle.

The length of time cattle in the surveillance pens were fed in the feedlot **(Days on feed - DOF)** ranged from 77 to 329 days (mean 173) with average daily gains **(ADG)** ranging from 0.89 to 1.84 kilograms (liveweight) per head per day. The performance parameters for the 4 groups in each of the 6 feedlots are summarised in Table 1 and listed in detail for each group in Appendix 2.

Table 1.

Production Performance of Surveillance Cattle

Feedlot	Range DOF	Mean DOF	Range ADG	Mean ADG
1	83 -143	111	1.30 - 1.77	1.63
2	136 - 183	161	1.18 - 1.82	1.43
3	91 - 179	128	1.30 - 1.53	1.44
4	77 - 201	112	1.30 - 1.84	1.46
5	235 - 329	280	0.89 - 1.22	1.01
6	240 - 268	254	0.90 - 1.20	1.02

3. Studies of Sentinel Cattle.

The incidence of disease and death in the sentinel cattle was not significantly different to the rest of the cattle in the surveillance pens. As a consequence it is believed that these sentinel animals were truly representative of the entire pen. Twenty eight (5.6%) of the 500 sentinel cattle were treated for illness and 6 (1.2%) died.

(a) Serological Monitoring for Viral Infections.

When animals are first infected with a virus, it generally takes from 2-3 weeks before specific antibodies to the virus can be detected in the serum. Therefore, detection of antibody to a virus suggests that an animal was infected at least 2 weeks previously. As a consequence, if animals do not have antibodies to a virus on entry to the feedlot, it is likely that they are either still susceptible to infection or have been infected within the last 2 weeks. In most cases, the absence of antibody at entry indicates no prior exposure on farm but animals may often become infected during the close contact and intensive management associated with transport and, perhaps,

movement through saleyards. Similarly, the detection of antibody at 6 weeks after entry in animals which were previously seronegative (no detectable antibodies) suggests that they were infected in the period around entry to the feedlot or in the first 3-4 weeks in the feedlot.

Serum samples were collected from 500 sentinel cattle on entry to the feedlot. At 6 weeks after entry, tests were conducted on 479 samples due to the loss of 21 sera. A total of 395 animals were sampled at slaughter.

(i) Prevalence of Viral Antibody at Entry

Antibodies against each of the four viruses were detected, but at differing rates, in cattle at the time of induction, indicating that there had been infection with these agents on farm. The ranges in apparent susceptibility to each of the viruses of individual surveillance groups within each feedlot are shown in Figures 1 - 4. The detail for each specific virus is as follows:

Pestivirus (BVDV) - Of the 500 sentinel cattle in this study, 68% (340) had antibodies to pestivirus (BVDV) on entry to the feedlot, or, 32% of animals were susceptible to infection with BVDV. Within each feedlot, the proportion of sentinel animals in each of the study groups which were susceptible (no detectable antibodies) to BVDV on entry ranged from:

Feedlot 1	5 - 50%
Feedlot 2	0 - 55%
Feedlot 3	20 - 60%
Feedlot 4	25 - 60%
Feedlot 5	20 - 55%
Feedlot 6	5 - 25%

These variations in the proportion of susceptible cattle are shown graphically in Figure 1. The proportion (%) of susceptible sentinel cattle within groups is listed in Table 2. There is considerable variation in the proportion of susceptible cattle in these groups. These variations in the proportion of susceptible animals were not related to the age of the cattle or their origin. There were 12 groups in which at least 75% of the sentinel cattle appeared to be immune. There were usually 1 or 2 groups of cattle at each feedlot with a low proportion of animals which were susceptible to BVDV but in Feedlot 6 there was a low proportion of susceptibles in all groups studied. None of the sentinel cattle were found to be carriers of pestivirus.

TABLE 2: PROPORTIONS OF SENTINEL CATTLE SUSCEPTIBLE TO EACH VIRUS AT ENTRY.

GRP	F/LOT	GRP SIZE	BVDV		IBR VIRUS		PI3 VIRUS		RSV	
			SUSC	PROP'N	SUSC	PROP'N	SUSC	PROP'N	SUSC	PROP'N
1	1	20	7	35%	17	85%	4	20%	14	70%
2	1	20	10	50%	15	75%	9	45%	15	75%
3	1	20	6	30%	18	90%	3	15%	17	85%
4	1	20	8	40%	19	95%	11	55%	19	95%
5	1	20	1	5%	18	90%	8	40%	15	75%
6	2	20	0	0%	16	80%	12	60%	9	45%
7	2	20	11	55%	18	90%	3	15%	10	50%
8	2	20	6	30%	19	95%	8	40%	15	75%
9	2	20	5	25%	20	100%	9	45%	11	55%
10	3	20	4	20%	19	95%	6	30%	16	80%
11	3	19	11	58%	19	100%	11	58%	16	84%
12	3	20	5	25%	6	30%	20	100%	20	100%
13	3	20	12	60%	20	100%	11	55%	16	80%
14	4	20	12	60%	20	100%	0	0%	16	80%
15	4	20	5	25%	19	95%	10	50%	18	90%
16	4	20	5	25%	16	80%	17	85%	14	70%
17	4	20	8	40%	20	100%	4	20%	13	65%
18	5	20	11	55%	19	95%	13	65%	14	70%
19	5	20	10	50%	19	95%	0	0%	14	70%
20	5	20	4	20%	16	80%	6	30%	16	80%
21	5	20	6	30%	19	95%	11	55%	9	45%
22	6	20	4	20%	16	80%	9	45%	16	80%
23	6	20	3	15%	20	100%	6	30%	15	75%
24	6	20	1	5%	14	70%	10	50%	10	50%
25	6	20	5	25%	12	60%	12	60%	18	90%

Infectious Bovine Rhinotracheitis (IBR) Virus - In contrast to the situation with BVDV, by far the majority of cattle entering the 6 feedlots appear to be susceptible to IBR virus. Within each feedlot, the proportion of sentinel animals in each of the study groups which were susceptible to IBRV on entry ranged from:

Feedlot 1	75 - 95%
Feedlot 2	80 - 100%
Feedlot 3	30 - 100%
Feedlot 4	80 - 100%
Feedlot 5	80 - 95%
Feedlot 6	60 - 100%

These variations in the proportion of susceptible cattle are listed in Table 2 and depicted in Figure 2. Overall, 87% of sentinel animals were susceptible to infection with significant differences between feedlots (χ^2 $p < 0.05$). There was only 1 group of cattle with a low proportion (30%) of cattle susceptible to IBR virus at entry. In all other groups at least 60%, and mostly (22/25 groups) >75% of cattle were susceptible.

Parainfluenza 3 (PI3) Virus - There was greater variability in the proportion of animals that were susceptible to PI3 virus than for any of the other viruses (See Table 2 and Figure 3). All sentinels in some groups were susceptible while in others all were immune. The proportion of sentinel animals susceptible to PI3 on entry in each feedlot for individual groups ranged from:

Feedlot 1	15 - 55%
Feedlot 2	15 - 60%
Feedlot 3	30 - 100%
Feedlot 4	0 - 85%
Feedlot 5	0 - 65%
Feedlot 6	30 - 60%

Overall, 43% of sentinel animals entering the feedlots were susceptible to PI3. There were significant differences ($p < 0.05$) in the susceptibility of cattle over all groups between feedlots. The proportion of sentinel cattle

Figure 1 Susceptibility to BVDV on Entry. Range and Mean - by Feedlot

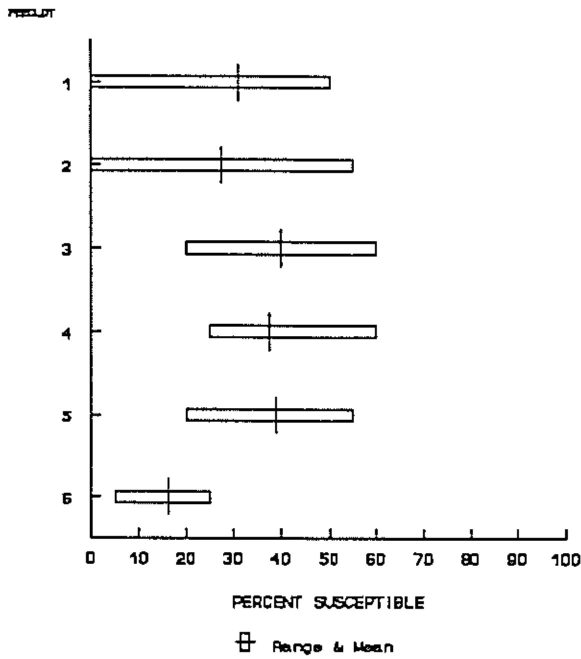


Figure 2 Susceptibility to IBR on Entry. Range and Mean by Feedlot

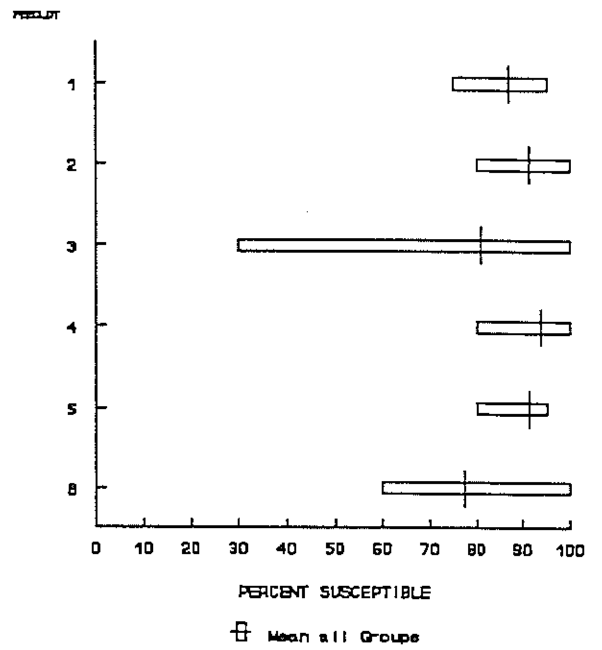


Figure 3 Susceptibility to PI3 on Entry. Range and Mean by Feedlot.

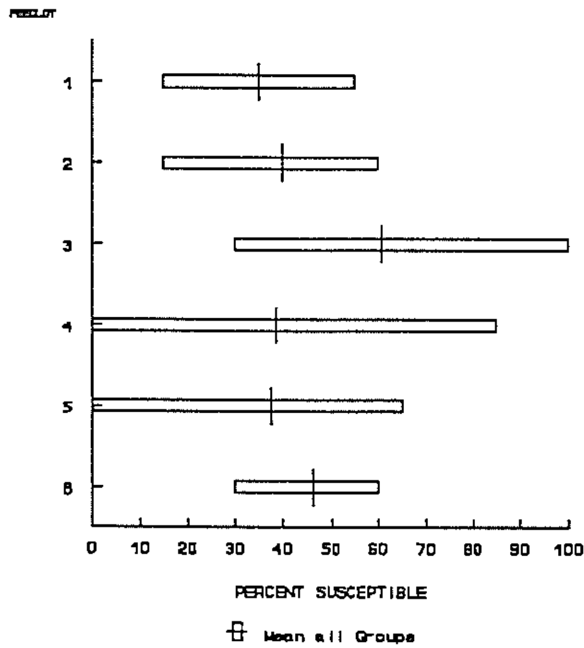
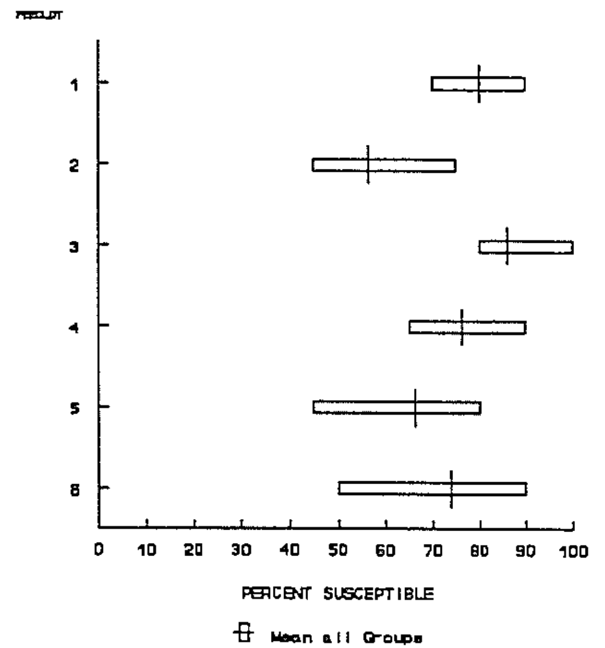


Figure 4 Susceptibility to RSV on Entry. Range and Mean by Feedlot.



susceptible in the individual groups is listed in Table 2. There were 2 groups with no susceptible cattle, 2 with 15%, 19 between 20 and 65% and 2 more than 85%.

Respiratory Syncitial Virus (RSV) - A high proportion of cattle entering feedlots appear to be susceptible to RSV virus. Within each feedlot, the proportion of sentinel animals in each of the surveillance groups which were susceptible to RSV on entry ranged from:

Feedlot 1	70 - 95%
Feedlot 2	45 - 75%
Feedlot 3	80 - 100%
Feedlot 4	65 - 90%
Feedlot 5	45 - 80%
Feedlot 6	50 - 90%

These variations in the proportion of susceptible cattle are depicted in Figure 4. Overall, 73% of sentinel cattle entering the feedlots were susceptible to RSV. The proportion of susceptible sentinel cattle in the individual groups is listed in Table 2. In most groups (21/25) the proportion of susceptibles ranged between 45 and 80%. In the other 4 groups, the proportions of susceptible cattle were 90% (2 groups), 95% & 100%.

(ii) Incidence of viral infections in the first 6 weeks in the feedlot
Testing for antibodies to the four viruses was carried out on serum samples collected at 6 weeks after entry to the feedlot from 479 of the sentinel cattle. The results for these tests can be expressed in several ways, as a total number (or proportion) of animals which give a positive test result at 6 weeks or as an incidence, that is, the proportion of susceptible animals which have become infected during the 6 week period from entry. The term seroconversion is also used to describe the change in serum antibody status of an animal, from negative to positive in consecutive tests, and in the current context, numbers of susceptibles becoming infected is synonymous with numbers seroconverting over the first 6 weeks on feed and incidence is equivalent to seroconversion rate. The calculation of the number of animals infected (or the incidence) is useful to permit a comparison of the numbers of animals which have recently become infected with various agents. This data is summarised in Table 3. The rates of seroconversion to the four viruses in all sentinel cattle are depicted in Figures 5 to 9 and for the

TABLE 3: SEROCONVERSION RATES OF SENTINEL CATTLE TO VIRUSES IN FIRST 6 WEEKS.

GRP	F/LOT	BVDV		IBR VIRUS		PI3 VIRUS		RSV	
		S/C	PROP'N	S/C	PROP'N	S/C	PROP'N	S/C	PROP'N
1	1	0/7	0%	3/17	18%	3/4	75%	6/14	43%
2	1	7/10	70%	1/15	7%	3/9	33%	7/15	47%
3	1	2/6	33%	3/18	17%	2/3	67%	12/17	71%
4	1	2/8	25%	4/19	21%	3/11	27%	6/19	32%
5	1	1/1	100%	14/18	78%	4/8	50%	10/15	67%
6	2	ND	ND	11/16	69%	1/12	8%	4/9	44%
7	2	3/11	27%	0/18	0%	0/3	0%	3/10	30%
8	2	0/6	0%	2/19	11%	3/8	38%	10/15	67%
9	2	4/5	80%	0/20	0%	4/9	44%	8/11	73%
10	3	4/4	100%	3/19	16%	5/6	83%	5/16	31%
11	3	11/11	100%	2/19	11%	9/11	82%	16/16	100%
12	3	5/5	100%	1/6	17%	5/20	25%	6/20	30%
13	3	9/12	75%	1/20	5%	2/11	18%	3/16	19%
14	4	12/12	100%	14/20	70%	0/0	ND	6/16	38%
15	4	3/5	60%	10/19	53%	3/10	30%	10/18	56%
16	4	5/5	100%	5/16	31%	14/17	82%	10/14	71%
17	4	8/8	88%	3/20	15%	2/4	50%	6/13	46%
18	5	1/11	9%	0/19	0%	3/13	23%	4/14	29%
19	5	6/10	60%	17/19	89%	0/0	ND	10/14	71%
20	5	4/4	100%	12/16	75%	5/6	83%	11/16	69%
21	5	5/6	83%	14/19	74%	5/11	45%	7/9	78%
22	6	4/4	100%	5/16	31%	9/9	100%	13/16	81%
23	6	2/3	67%	0/20	0%	4/6	67%	10/15	67%
24	6	0/1	0%	9/14	64%	6/10	60%	3/10	30%
25	6	4/5	80%	1/12	8%	3/12	25%	15/18	83%

ND= Not determined - no susceptible sentinels.

individual feedlots in Figures 10 to 15. These seroconversion rates should only be used as a guide as the small numbers of susceptible animals in some groups (especially for BVDV and PI3) may limit the accuracy of the estimate of the seroconversion rate. However, there did not appear to be any seasonal trends in the variations in seroconversion rates for any of the viruses. Specific features for the individual viruses are as follows:

BVD Virus - Of the 159 sentinels susceptible to BVDV on entry to the feedlot, sera were collected at 6 weeks after entry from 144. Seroconversion was observed in 102 (68%) of the 144 sentinels, indicating that they had been infected immediately prior to entry to the feedlot or in the first 4 weeks in the feedlot. The seroconversion rates for sentinels in each group are listed in Table 3. As indicated previously, the BVDV seroconversion rates should be treated as estimates because of the small numbers of susceptible animals in some groups. There were 12 groups with not more than 5 susceptible animals in the sentinel group.

For individual groups, the ranges in seroconversion rates of susceptible sentinels to BVDV in the first 6 weeks were:

Feedlot 1	0 - 70%
Feedlot 2	0 - 80%
Feedlot 3	75 - 100%
Feedlot 4	60 - 100%
Feedlot 5	9 - 100%
Feedlot 6	0 - 100%

IBR Virus - From 434 sentinel animals identified at entry as susceptible to IBR virus, samples were available for testing from 414 at 6 weeks after entry. Of these 414, 29% (120) had seroconverted, indicating that they had been infected immediately prior to entry to the feedlot or in the first 4 weeks in the feedlot. The seroconversion rates for sentinels in each group are listed in Table 3. The differences in the rates of seroconversion between feedlots (taken over all groups) were highly significant ($p<0.05$). There were 15 groups with less than 20% of the sentinels seroconverting. At the other extreme there were 6 groups with rates of approximately 70% or greater.

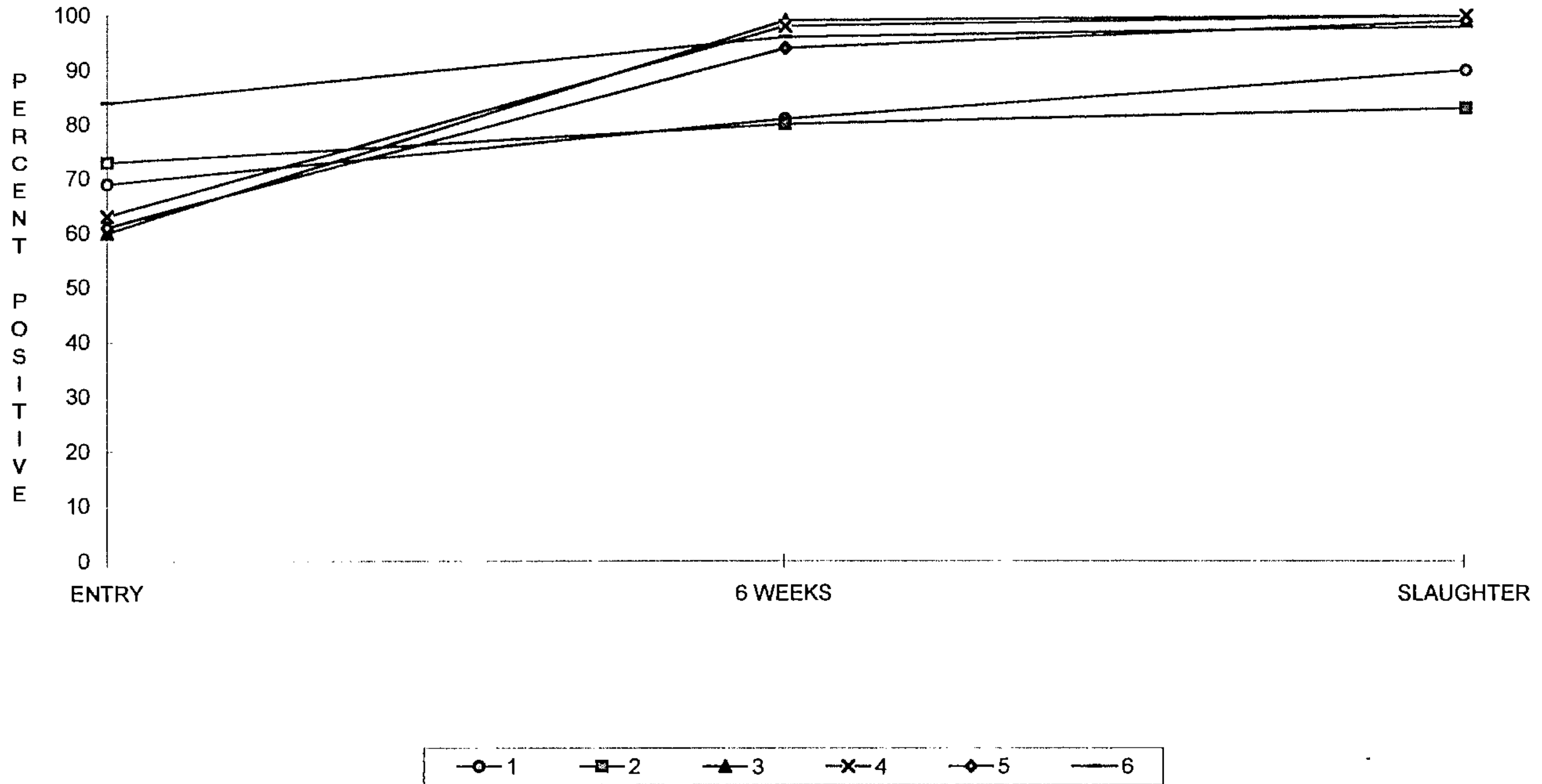


Figure 5

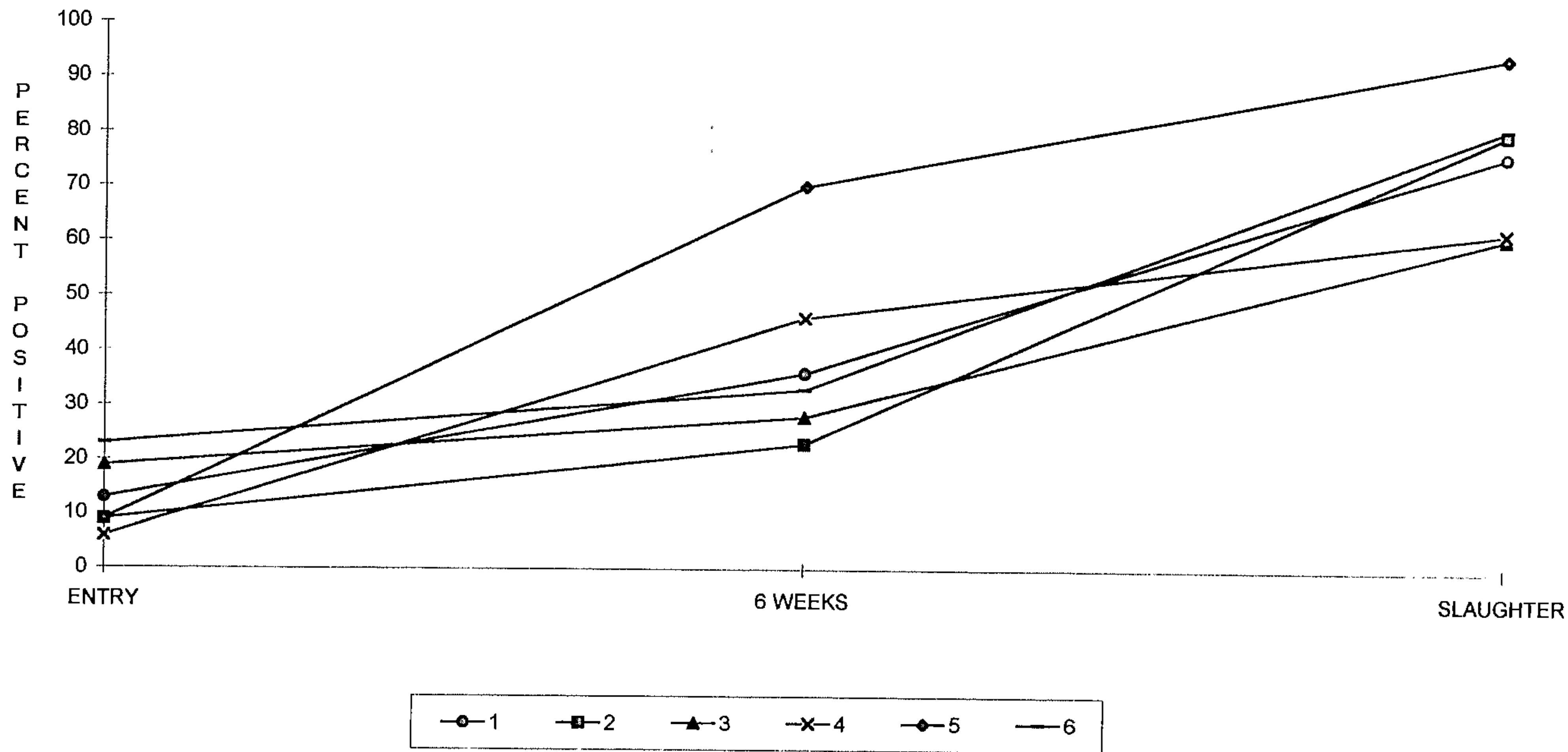


Figure 6

For individual groups, the ranges in seroconversion rates of susceptible sentinels to IBRV in the first 6 weeks were:

Feedlot 1	7 - 78% (1 group=78% & the other 4 groups were <25%)
Feedlot 2	0 - 69% (3 groups <15%)
Feedlot 3	5 - 17% (All groups <20%)
Feedlot 4	15 - 70%
Feedlot 5	0 - 89% (3 groups 74-89%)
Feedlot 6	0 - 64%

In addition to the animals which seroconverted during this 6 week period, there were a further 15 animals which had indications of recent IBR virus infections. These were amongst the 65 sentinel animals identified as having antibody to IBR at entry but their antibody titres were shown to rise significantly (by more than 4 fold) during the initial 6 weeks in the feedlot. These animals may have become infected with IBR in the few weeks just prior to entering the feedlot or may have been animals which had been infected at some much earlier time, and were experiencing a resurgence, perhaps stress-induced, of a latent infection. These are important animals in the epidemiology of IBR virus as they may have been excreting virus when they entered the feedlot and provide a source of infection for others. There was no significant difference in the occurrence of these animals between feedlots.

PI3 Virus- From 214 sentinels susceptible to PI3 on entry to the feedlot, 201 were available for follow up 6 weeks later. Ninety seven (48%) of these animals had seroconverted to PI3 in this 6 week period. The differences in seroconversion rates between feedlots (across all groups) were significant (χ^2 $p < 0.05$). However, as with BVDV, these seroconversion rates should be treated as estimates for some groups because of the small numbers of susceptible animals. There were 2 groups without any susceptible sentinels. The seroconversion rates for sentinels in each group are listed in Table 3.

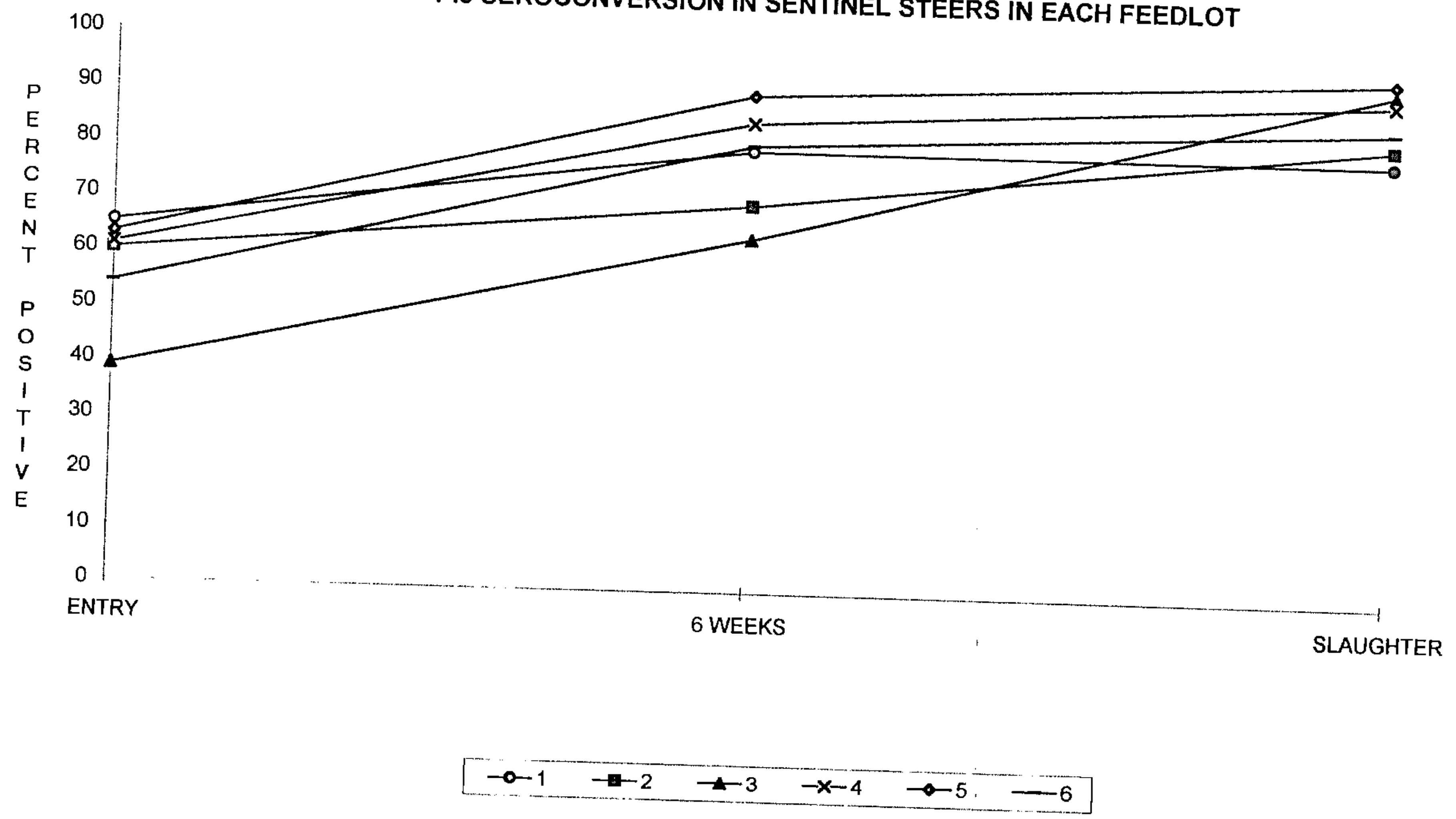


Figure 7

For individual groups, the ranges in seroconversion rates of sentinels to PI3 in the first 6 weeks were:

Feedlot 1	27 - 75%	
Feedlot 2	0 - 44%	
Feedlot 3	18 - 83%	
Feedlot 4	30 - 82%	(one group with no susceptibles)
Feedlot 5	23 - 83%	(one group with no susceptibles)
Feedlot 6	25 - 100%	(although in 3/4 groups only small numbers of animals were involved)

RSV - Of the 366 sentinels susceptible to RSV on entry to the feedlots, 348 were sampled at 6 weeks and 200 (57%) of these seroconverted to RSV. The seroconversion rates for sentinels in each group are listed in Table 3. There were significant differences in the rates of seroconversion of sentinels in the first 6 weeks between feedlots (χ^2 $p < 0.05$). The groups in Feedlot 3 were particularly notable in that all animals seroconverted in one group while the other 3 groups ranged from 19% to 31%. When groups were aggregated within a feedlot, there was little variation in the rates between lots (note the similar slope on the RSV graphs in Figs 10-15). For individual groups, the ranges in seroconversion rates of sentinels to RSV in the first 6 weeks were:

Feedlot 1	32 - 71%
Feedlot 2	30 - 73%
Feedlot 3	19 - 100%
Feedlot 4	38 - 71%
Feedlot 5	29 - 78%
Feedlot 6	30 - 83%

(iii) Incidence of viral infections in the period from 6 weeks after induction to slaughter

At the end of the first 6 weeks in the feedlots, the outstanding feature was the high proportion of animals which were apparently still susceptible to IBR virus. There were 294 (61%) of the available sentinel cattle still susceptible to IBRV, but only 44 (9%) to BVDV, 104 (22%) to PI3 virus and 148 (31%) to RSV (See Figures 5 - 15).

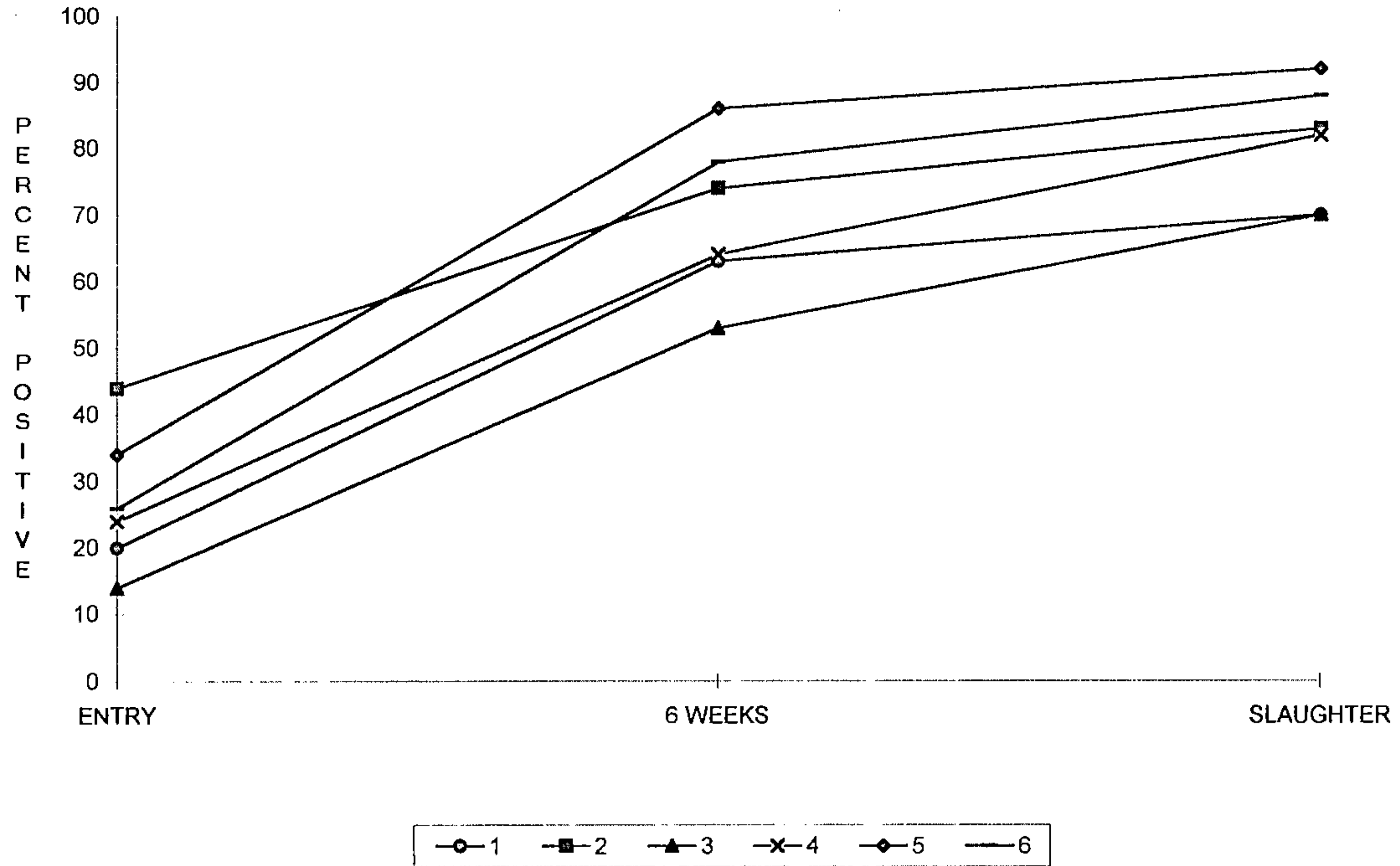


Figure 8

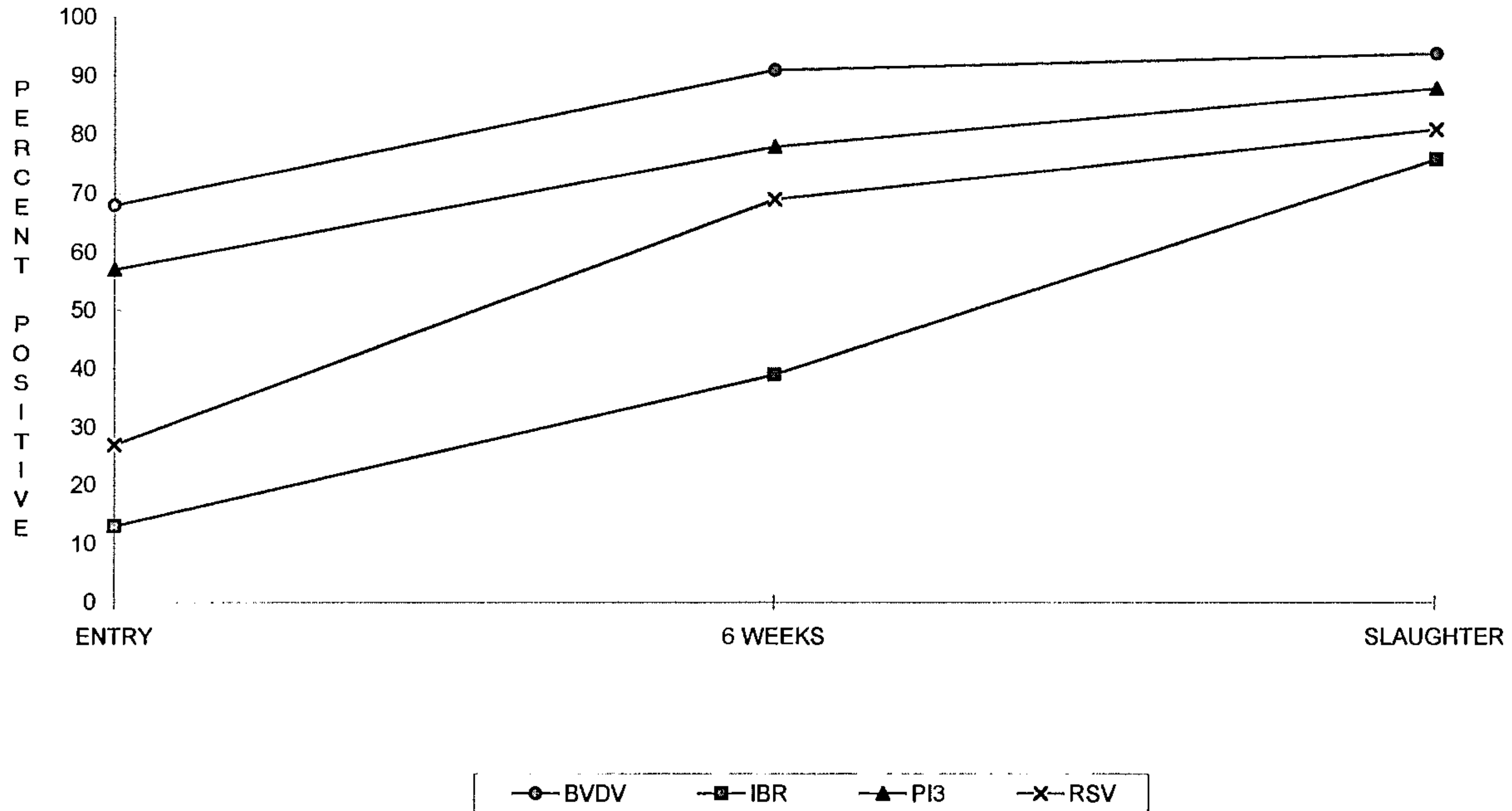


Figure 9

BVDV - Of the 44 susceptible sentinels, 32 were sampled at slaughter and 22 of these were still seronegative. Testing at entry had shown that these remaining seronegative animals were not persistently infected carriers of the virus. Between 6 weeks and slaughter, the seroconversion rate to BVDV of susceptible sentinels in individual groups ranged from:

Feedlot 1	0 - 67%
Feedlot 2	0 - 25%
Feedlot 3	100%
Feedlot 4	100%
Feedlot 5	67 - 100%
Feedlot 6	0%

IBR Virus - In the remaining time in the feedlot, there was a relatively high incidence of infection with IBRV (see Figures 6 & 9). From 294 sentinels still susceptible to IBR at 6 weeks, 229 were sampled at slaughter. Of these, 59% (135) had seroconverted at slaughter. There were significant differences in the seroconversion rates for IBR between feedlots (χ^2 $p < 0.001$) (compare Figures 10-15).

For each feedlot between 6 weeks and slaughter, the seroconversion rate to IBRV of susceptible sentinels in individual groups ranged from:

Feedlot 1	20 - 92%
Feedlot 2	67 - 94%
Feedlot 3	21 - 100%
Feedlot 4	0 - 75%
Feedlot 5	0 - 89%
Feedlot 6	50 - 86%

PI3 Virus - At slaughter, samples were collected from 83 of the 104 sentinels that were still susceptible to PI3 6 weeks after entry to the feedlot. Thirty six (43%) of these seroconverted between 6 weeks and slaughter. For each feedlot between 6 weeks and slaughter, the seroconversion rate of susceptible sentinels to PI3 virus ranged from:

Feedlot 1	0 - 57%
Feedlot 2	0 - 78%
Feedlot 3	0 - 100%
Feedlot 4	0 - 67%
Feedlot 5	33 - 100%
Feedlot 6	0 - 33%

RSV - Of the 148 animals that were still susceptible at 6 weeks, 120 were sampled at slaughter and 46 (38%) had seroconverted to RSV. There was no significant difference between the seroconversion rates from 6 weeks to slaughter between feedlots. For each feedlot seroconversion to RSV in susceptible sentinels between 6 weeks and slaughter ranged from:

Feedlot 1	0 - 40%
Feedlot 2	0 - 67%
Feedlot 3	20 - 71%
Feedlot 4	0 - 70%
Feedlot 5	33 - 50%
Feedlot 6	40 - 50%

Prevalence of antibody to each virus at slaughter - At slaughter, 94% (367/389) of the sentinel cattle sampled had been infected with BVDV, 76% (295/389) with IBR, 88% (342/389) with PI3 and 81% (315/389) with RSV.

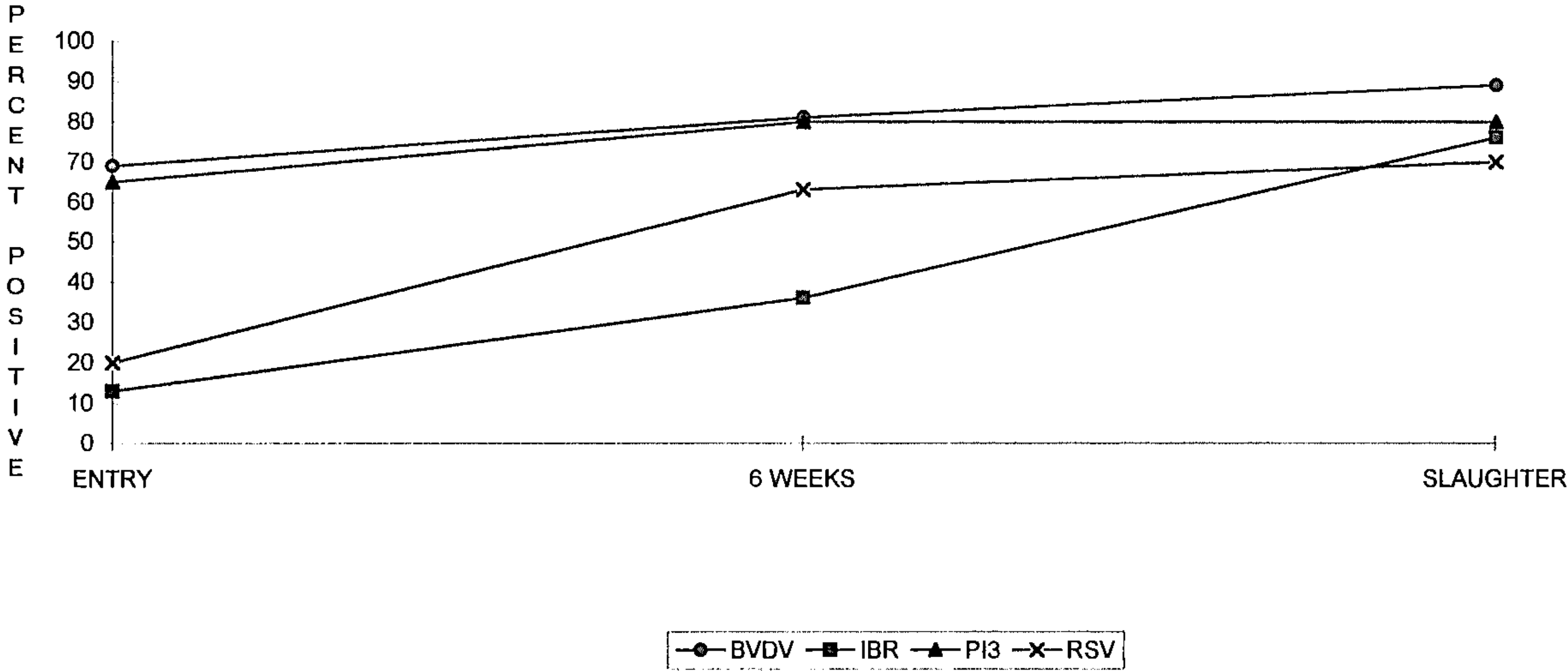


Figure 10

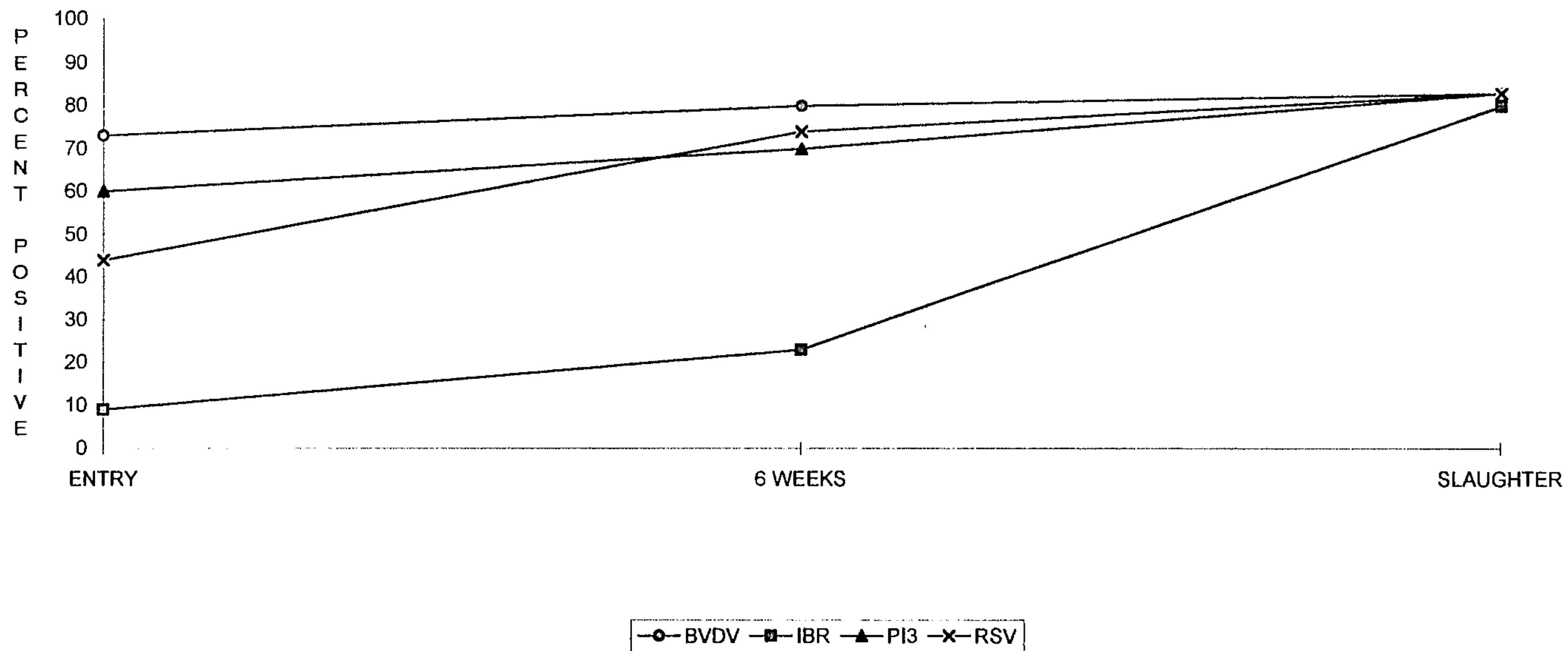


Figure 11

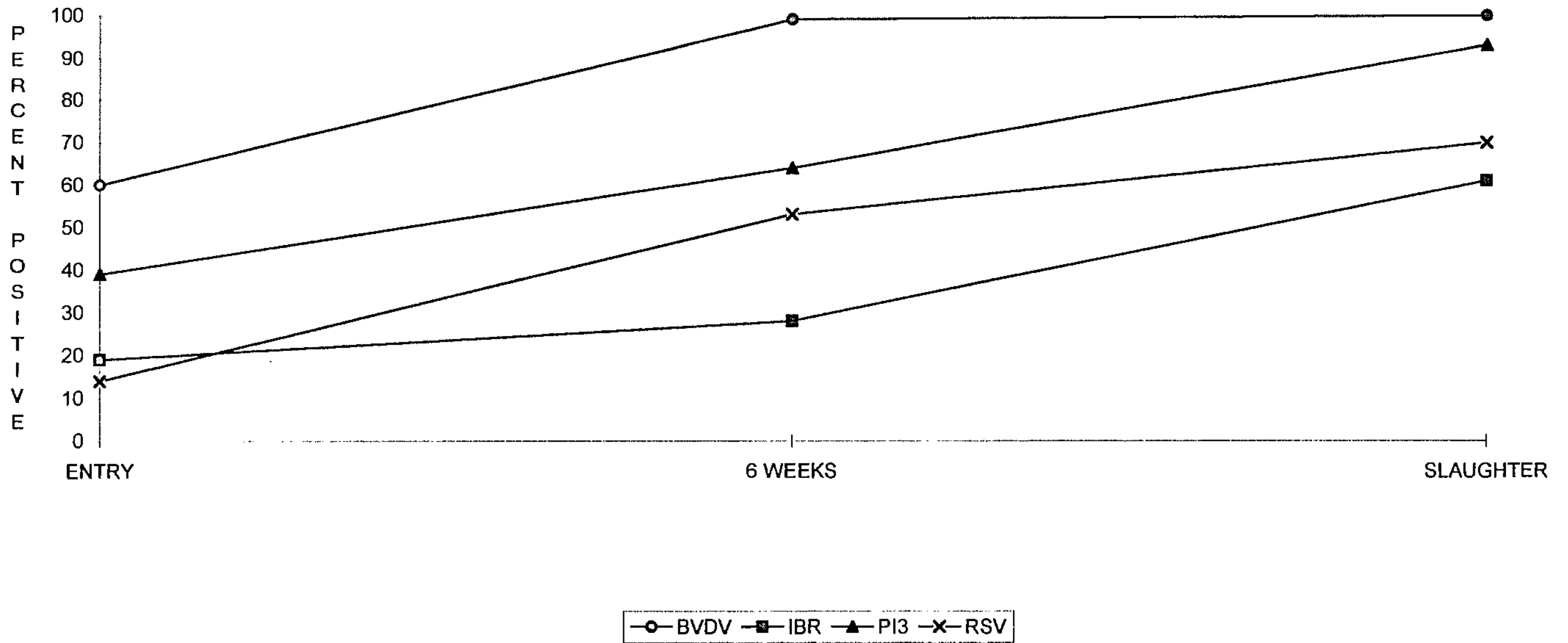


Figure 12

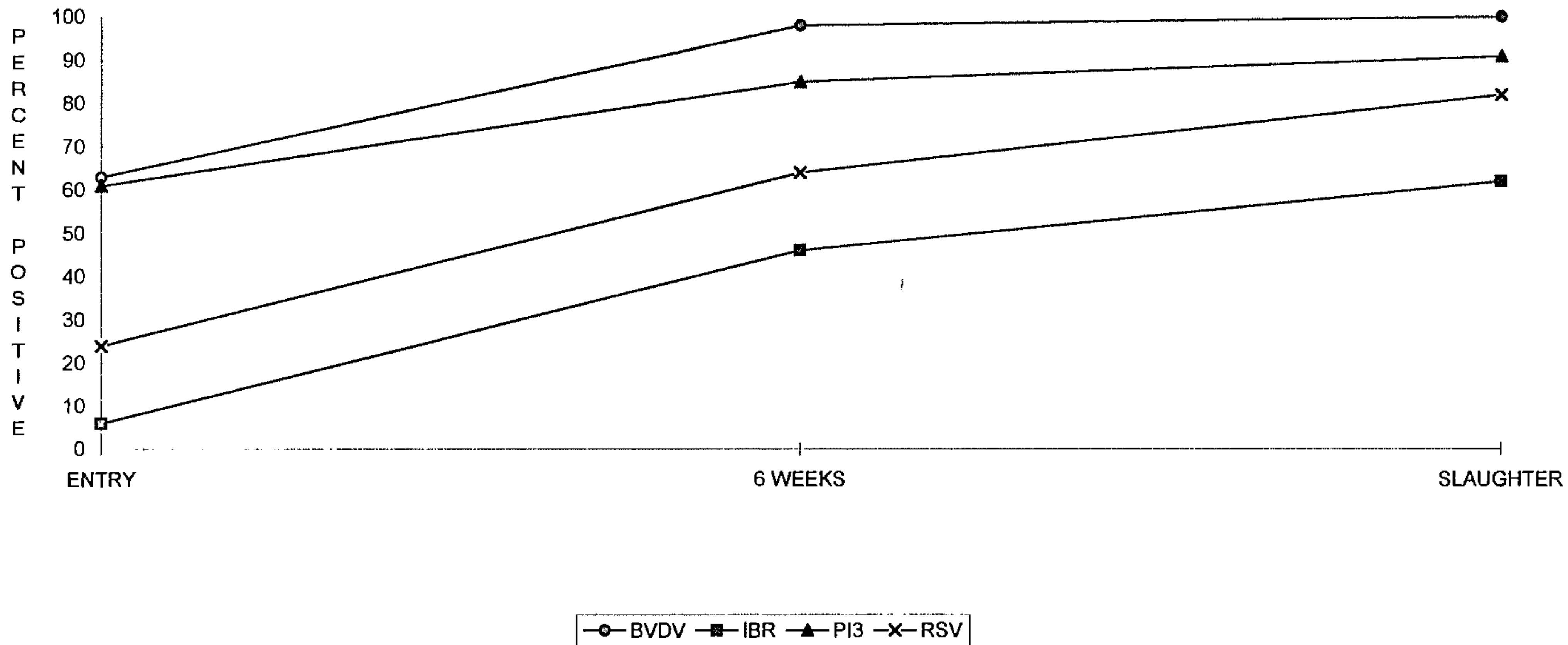


Figure 13

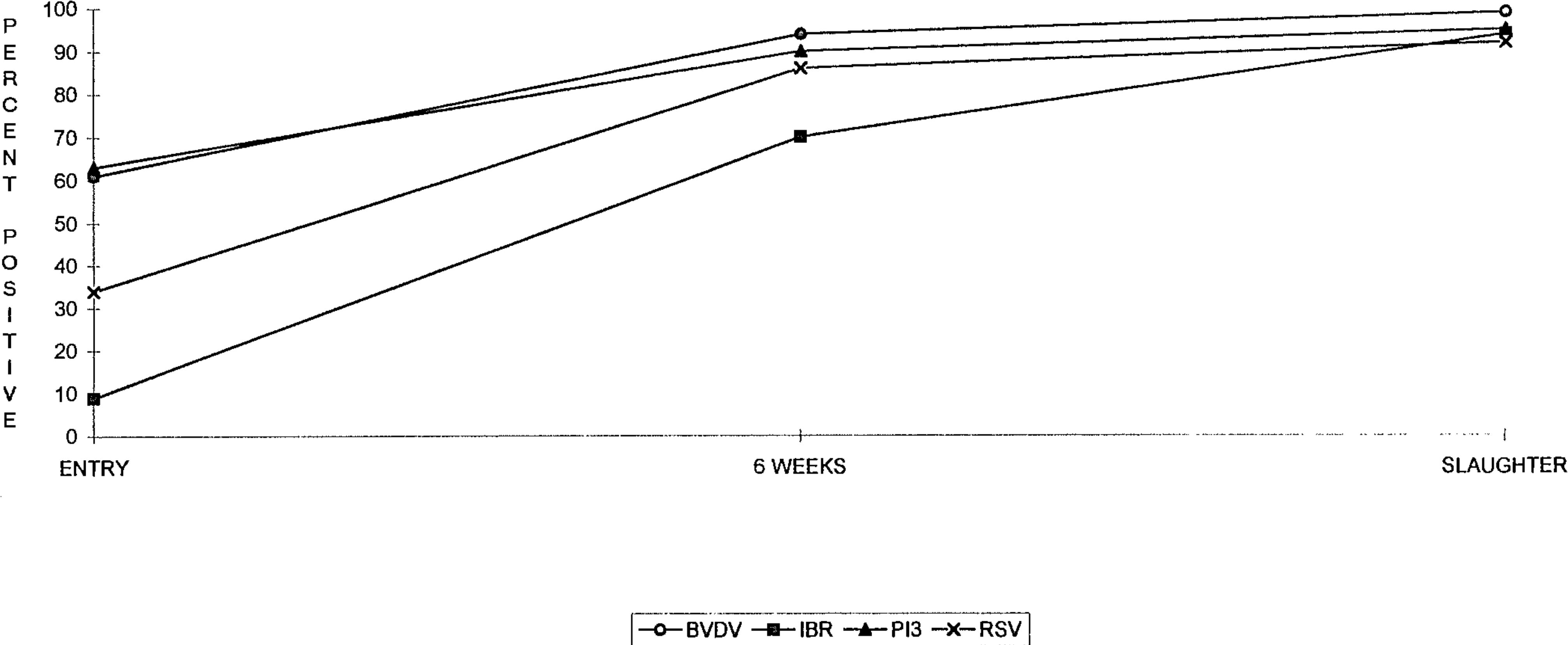


Figure 14

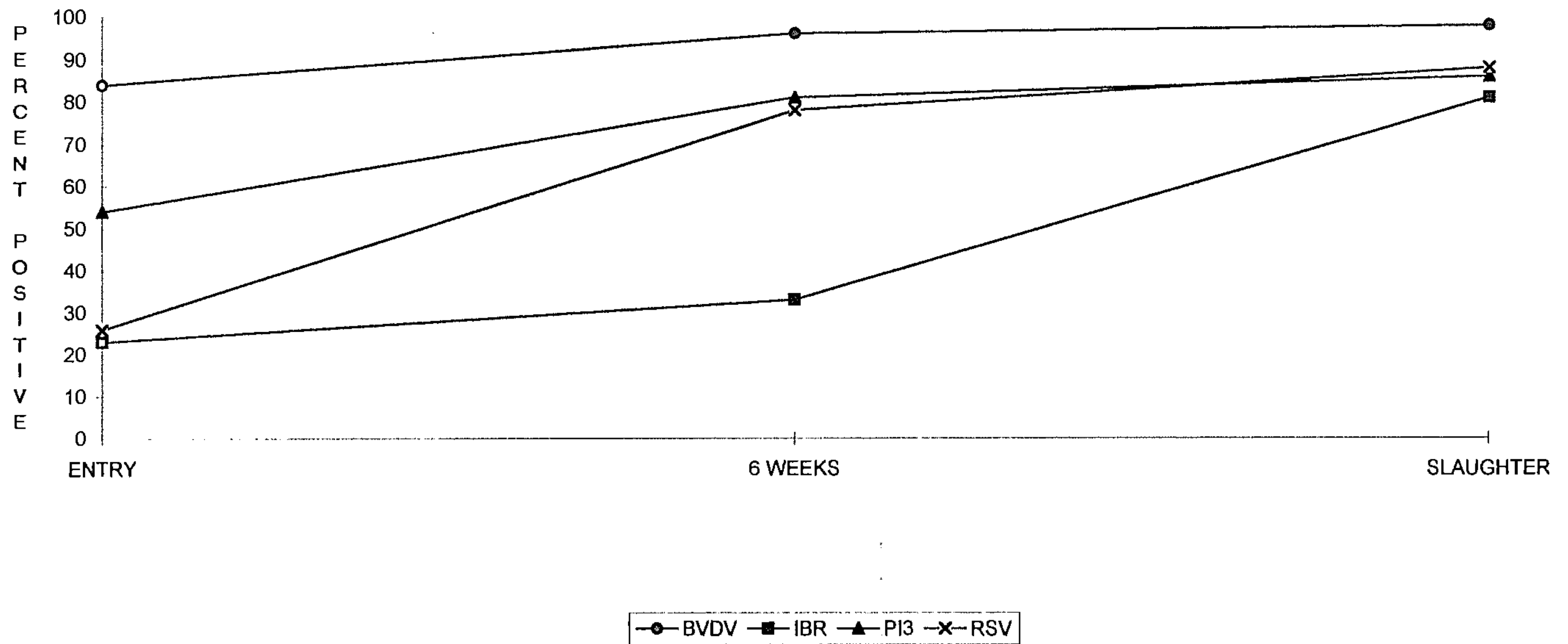


Figure 15

(iv) **Interactions between viruses**

When the serological results were examined for individual sentinel animals, it was found that many animals had been infected with more than one virus during the first 6 weeks in the feedlot. The interactions between infections with the different viruses are complex and are depicted in Figure 16.

Overall, 72% (347/479) of all sentinel cattle had seroconverted to one or more viruses in the 6 weeks after feedlot induction. Seroconversion to BVDV had occurred in 21% (102/479) of the sentinel animals sampled 6 weeks after induction. Rates of seroconversion to IBR, PI3 and RSV were 28% (135/479), 20% (98/479) and 42% (201/479) respectively. Only 1.3% (6/479) of sentinel animals had seroconverted to all 4 viruses. Seroconversion to 3 viruses had occurred in 4.8% (23/479) and seroconversion to 2 viruses had occurred in 26% (125/479) of sentinel cattle. Seroconversion to a single virus had occurred in 40% (193/479) of sentinel animals 6 weeks after induction.

In the 102 sentinel animals with seroconversion to BVDV there were 34 (7.1% of all sentinels) with seroconversion to BVDV only, 14 (2.9%) with seroconversion to BVDV and IBR only, 20 (4.2%) with seroconversion to BVDV and RSV only, 9 (1.9%) with seroconversion to BVDV and PI3 only, 9 (1.9%) with seroconversion to BVDV, IBR and RSV only, 1 (0.2%) with seroconversion to BVDV, IBR and PI3 only and 6 (1.3%) with seroconversion to BVDV, IBR, PI3 and RSV.

In the 135 sentinel animals with seroconversion to IBR virus there were 35 (7.3%) with seroconversion to IBR and RSV only, 12 (2.5%) with seroconversion to IBR and PI3 only and 4 (0.8%) with seroconversion to IBR, PI3 and RSV only as well as the combinations of seroconversions listed above.

In the 98 sentinel animals with seroconversion to PI3 virus there were 22 (4.6%) with seroconversion to PI3 only and 35 (7.3%) with seroconversion to PI3 and RSV only as well as the combinations of seroconversions listed previously.

In the 201 sentinel animals with seroconversion to RSV there were 83 (17%) with seroconversion to RSV only as well as the previously described combinations.

SEROCONVERSIONS TO BVDV, IBR, PI3 AND RSV IN 479 SENTINEL CATTLE IN THE FIRST SIX WEEKS ON FEED

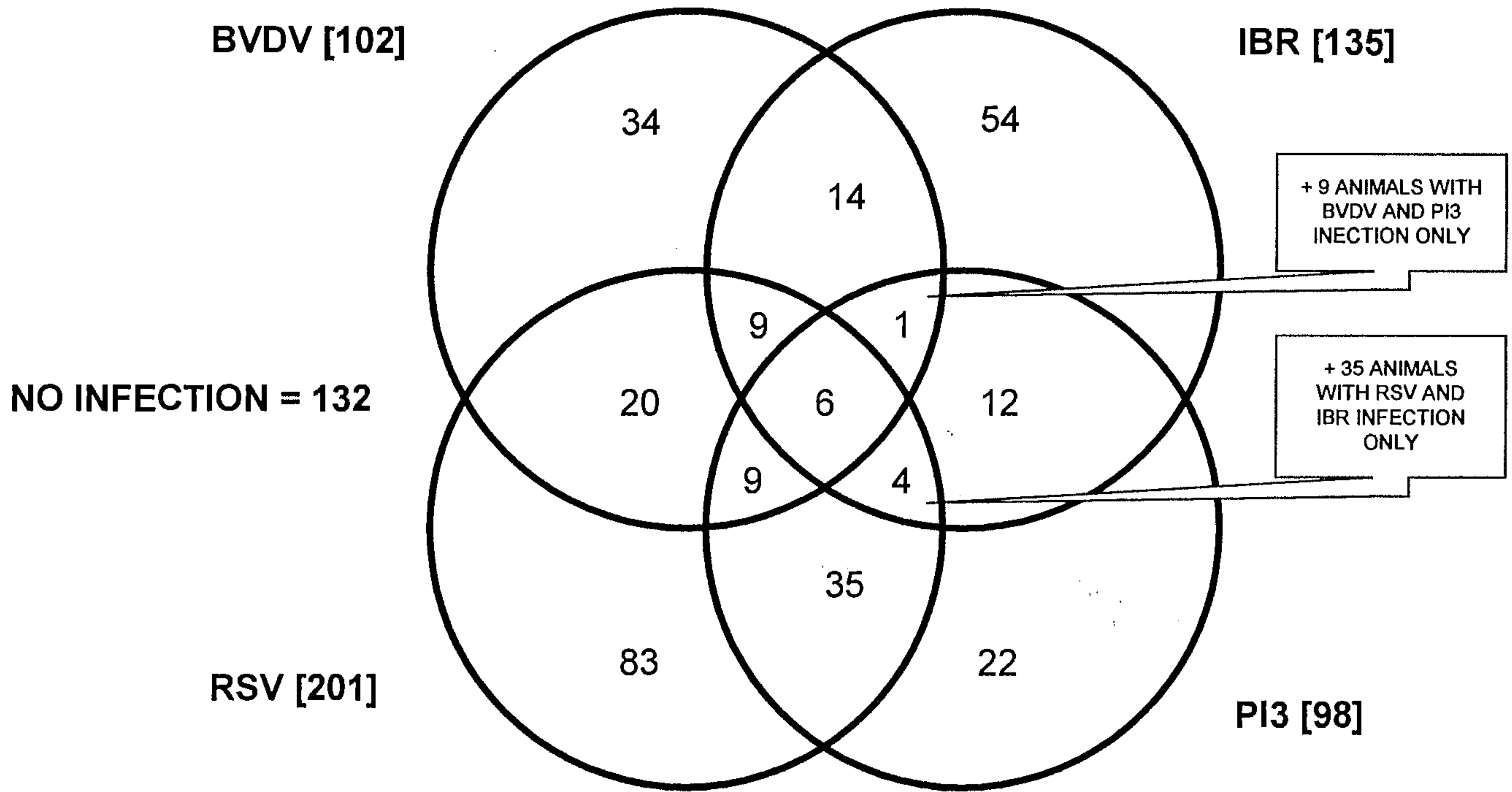


FIGURE 16

4. Investigations of Disease in Feedlot Cattle.

(a) Sick Cattle in Surveillance Pens.

During the study, efforts were directed at the early detection and collection of samples from sick animals. Pens of cattle were examined at least once every day to detect early signs of illness. Signs of illness included fever at entry (see methods, 4(c)(iii)), nasal and ocular discharges, inappetence, lameness and recumbency. Samples were always collected before any treatment was undertaken.

During the course of the study, 359 cases of sickness (involving 345 animals) in the surveillance groups were investigated. Of these cases, 331 animals were identified as being sick and removed for treatment on a single occasion and 14 were found to be sick on two separate occasions. The number of sick animals per feedlot ranged from 30 to 114. The number of sick animals in each surveillance pen is listed in Appendix 2. Of the 345 sick animals, 28 were sentinels.

The rate of illness in the surveillance pens was 6.8% (number of cases/ number of animals in surveillance pens). This was comparable to the 5.8% morbidity rate found in feedlots during the original survey. From all cases, 34% (122/359) were fever at entry and 32% (114/359) were respiratory disease and, together, accounted for 66% of all sick cattle (Figure 13).

(i) Animals with Fever at Entry.

For the purpose of this project, in an attempt to identify whether fever at entry was a risk factor associated with subsequent cases of BRD, fever at entry was classified as a sickness. However, only 2 of the 6 feedlots in the study treated animals with fever at entry with antibiotics and 1 of these feedlots only treated febrile animals in some lots. Rectal temperatures of the febrile cattle ranged from 40.4°C to 42.5°C. Of the 122 cattle with fever at entry, only 18% (22/122) received antibiotic treatment at induction.

The number of animals in an individual surveillance group with fever at entry varied greatly and ranged from 0 to 30 head (up to 14% of animals) (see Table 4 and Appendix 2). There was no apparent explanation for the consistently low incidence of febrile animals in Feedlot 6. These animals had a diversity in age, origin, distance travelled and holding time before induction similar to animals in the other feedlots. The only apparent difference was a higher proportion of animals immune to BVDV on entry to this feedlot. The significance of this difference is unknown.

At entry there were 24 animals requiring treatment for conditions other than fever (eg keratoconjunctivitis, bullers etc).

Table 4

Proportion of Surveillance Cattle with High Temperatures on Entry.

Feedlot	Mean (%)	Range (%)
1	6.3	1.3 - 14.0
2	3.9	1.5 - 6.1
3	3.7	1.0 - 9.0
4	7.5	2.7 - 10.2
5	3.1	0 - 10.0
6	0.6	0 - 0.8
ALL	4.0	0 - 14.0

(ii) Sickness after Entry

After cases of fever at entry, the most common condition was respiratory disease and, together, these comprised 66% of all illnesses. Thirty two percent (114/359) of sick animals were diagnosed as having respiratory disease and these accounted for 53.5% (114/213) of the sickness after entry. The next most common category of illness was lameness, comprising 14.5% (52/359) of cases of illness. The remaining 47 cases of disease encompassed a broad range of conditions including illthrift, gastrointestinal disorders, behavioural problems, and a number of undiagnosed illnesses (See Figure 17). There was no apparent difference in the incidence of disease in the different seasons.

The 213 disease events which were diagnosed in surveillance groups after the day of entry involved 205 animals These cases occurred between 2 and 308 days on feed. Of these, 75% (159/213) of cases (involving 147 animals) occurred in the first 4 weeks (see Figure 18), with 38% (81/213) occurring in the first week.

There were 3.9% (14/359) of animals which were identified as sick on 2 occasions, including 2.5% (9/359) which had been identified with fever at entry. There was no significant relationship between fever at entry and subsequent episodes of disease as there were 122 animals with fever at entry and only 9 were diagnosed with a subsequent illness. Of the 9 animals with fever at entry, 4 were treated for lameness between 11 and 46 days after induction, 2 steers were diagnosed with respiratory disease 20 days after induction, 2 were affected with gastrointestinal problems 6 days after induction and 1 was affected with a feed related problem 21 days after induction. Only the 2 animals with gastrointestinal problems at 6 days had been treated with antibiotics for the fever at induction. A steer treated for keratoconjunctivitis on entry was diagnosed with respiratory disease 20 days after induction. There were also 3 steers treated for lameness on day 2 and 3 after induction that were treated for respiratory disease 16 to 27 days later. One steer was treated twice for lameness at 16 and 63 days on feed.

Body weights of sick animals ranged from 105 kgs to 606 kgs with a mean of 297 kgs. Only 146 of the 205 animals which were sick after entry were hospitalised, the remainder were returned direct to their pens. Where recorded, length of treatment varied from 1 to 20 days, with an average of 5 days. Only 218 animals (including the fevers at entry) were treated, the most commonly

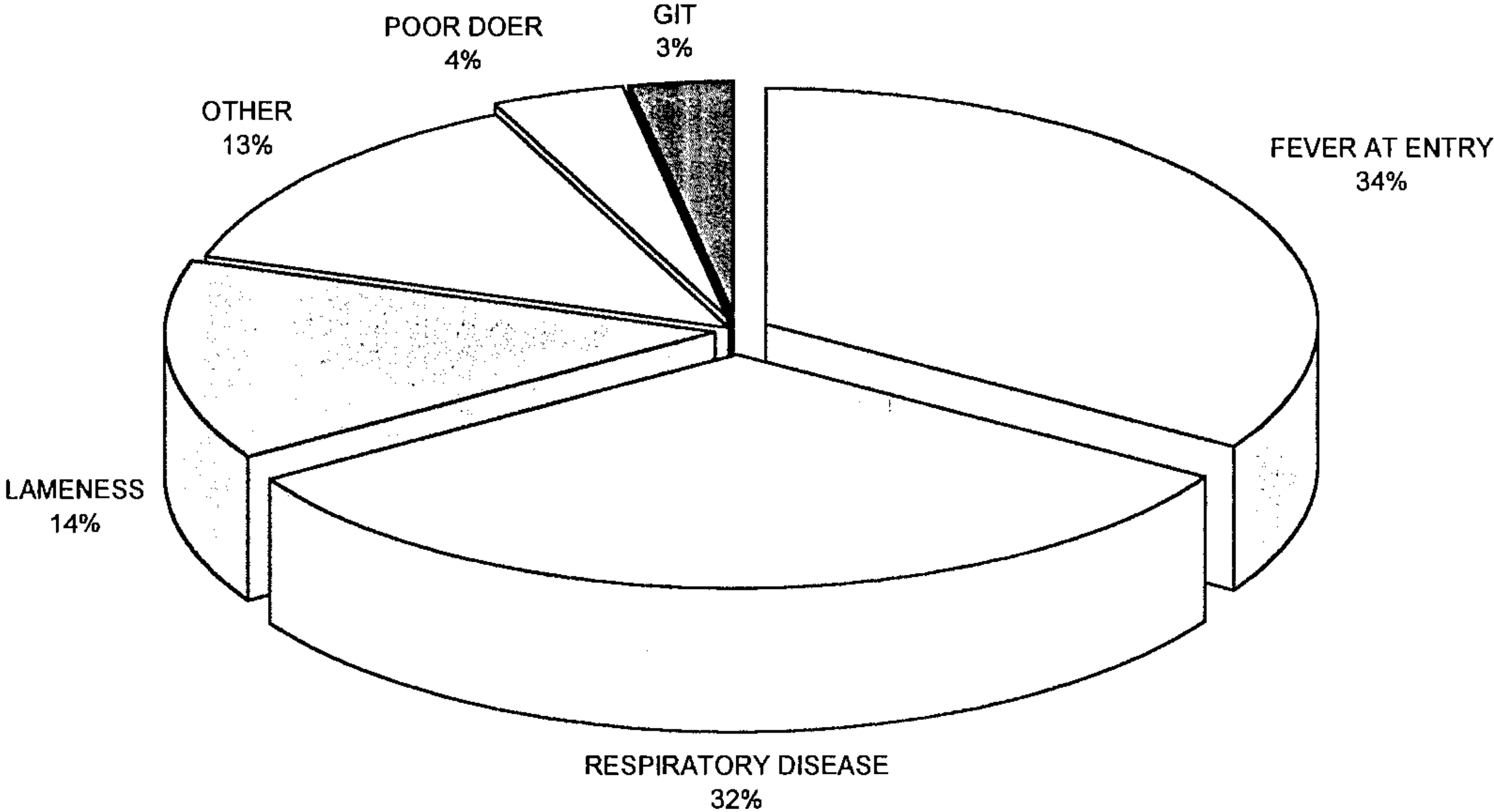


Figure 17

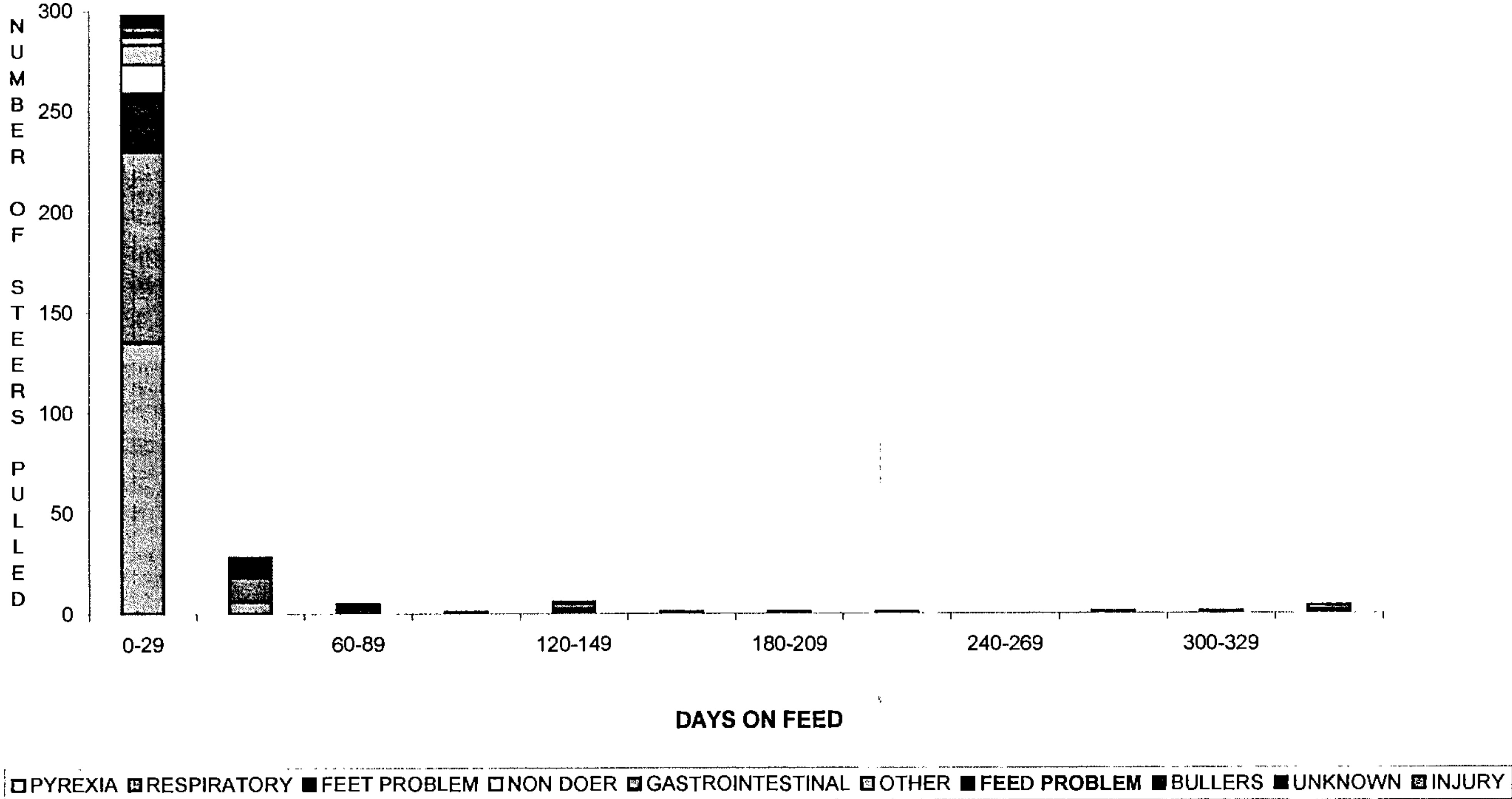


Figure 18

used antibiotic was long acting tetracycline. The number of days of treatment ranged from 1 to 6 days with a mean of 2½ days. There were 30 animals that received additional treatment with a variety of other medications. These were mainly another antibiotic or a combination anti-inflammatory/glucocorticoid. The majority of these second treatments were single doses. Overall, 91.8% of sick animals were returned to their pen while 3.1% were sent for salvage slaughter. Another 3.1% were retained in the hospital pen, 1.1% died and 0.6% were culled immediately.

(iii) Bacteriology in sick animals

Nasal swabs and faecal samples were collected from sick animals for bacteriology. In all, 602 cultures were performed on samples from 301 of the 359 cases. There were 284 faecal cultures, 193 cultures of nasal swabs, 107 combined cultures of nasal/ocular swabs and 18 cultures of ocular swabs. The range of bacterial isolates from sick animals, the condition which was diagnosed and the length of time that the animals had been on feed prior to illness are shown in Tables 5 & 6.

TABLE 5:

BACTERIA CULTURED FROM VARIOUS DISEASE CONDITIONS.

ISOLATE	TYPE OF DISEASE							
	FE	FT	GT	ND	OT	RE	UK	TOTAL
P. HAEMOLYTICA	13	2	1	0	1	3	1	21
P. MULTOCIDA	2	4	0	0	0	2	0	8
PASTEURELLA SPP	4	1	0	0	0	1	1	7
S. ANATUM	1	0	0	0	0	0	0	1
S. CHESTER	4	0	0	0	0	4	2	10
S. MUENCHEN	1	0	0	0	0	0	0	1
S. TYPHIMURIUM	0	0	1	0	0	7	0	8
NO SIG. GROWTH	139	42	8	14	13	83	21	320
TOTAL	164	49	10	14	14	100	25	376

* Disease categories: FE=fever, FT=foot problem, GT=gastrointestinal, ND='non-doer', OT=other, RE=respiratory, UK=unknown

TABLE 6:

RELATIONSHIP BETWEEN TIME OF SICKNESS AND BACTERIA ISOLATED

ISOLATE	DAYS ON FEED				
	0	1-30	31-60	>60	TOTAL
P. HAEMOLYTICA	18	2	0	1	21
P. MULTOCIDA	2	3	2	1	8
PASTEURELLA SPP	4	0	1	2	7
S. ANATUM	1	0	0	0	1
S. CHESTER	2	8	0	0	10
S. MUENCHEN	0	1	0	0	1
S. TYPHIMURIUM	0	5	1	2	8
NO SIG. GROWTH	132	124	32	32	320
TOTAL	159	143	36	38	376

Eighty one percent (245/301) of cases yielded no significant bacterial growth (Figure 19), even though the samples were collected from animals prior to treatment. Pasteurellae were cultured from 12% (36/301) of cases and Salmonellae from 6.6% (20/301). *Pasteurella haemolytica* was cultured from 21 animals (7%) and *P multocida* from 8 (2.7%) cases with isolates from another 7 (2.3%) animals identified as *Pasteurella spp.* Various *Salmonella spp* were cultured from 20 (6.6%) cases.

There were 19 isolations of *Pasteurella spp* isolated from steers with fever at entry which included 13 isolates of *P. haemolytica*, 2 isolates of *P. multocida* and 2 other *Pasteurella spp.* In addition to the 13 steers with fever at entry, *P haemolytica* was cultured from 3 steers with respiratory disease and 2 steers treated for lameness. As well as the 2 steers with fever at entry, *P*

BACTERIAL ISOLATES FROM SICK ANIMALS (301 CASES CULTURED)

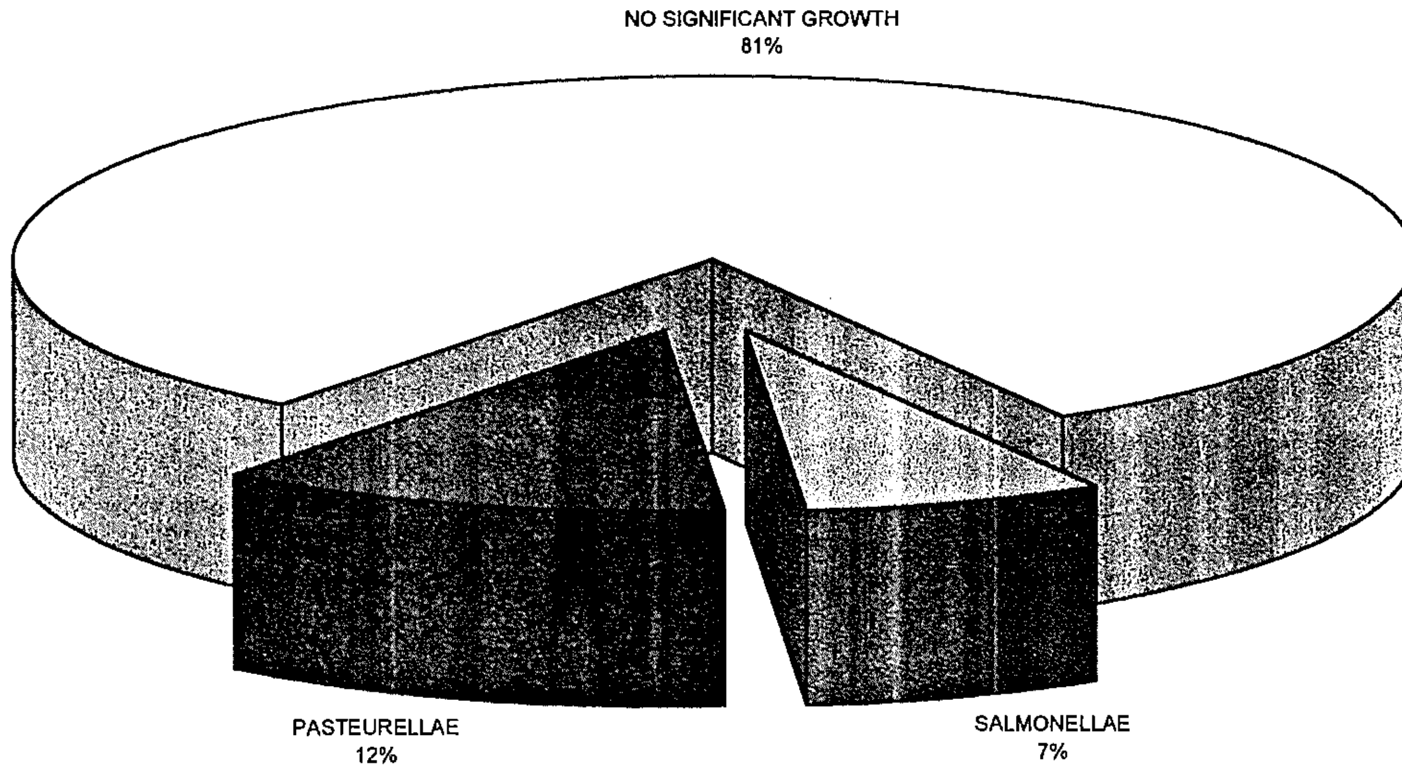


Figure 19

SEROCONVERSIONS TO (OR VIRUS ISOLATIONS OF) BVDV, IBR, PI3 AND RSV IN 318 SICK ANIMALS

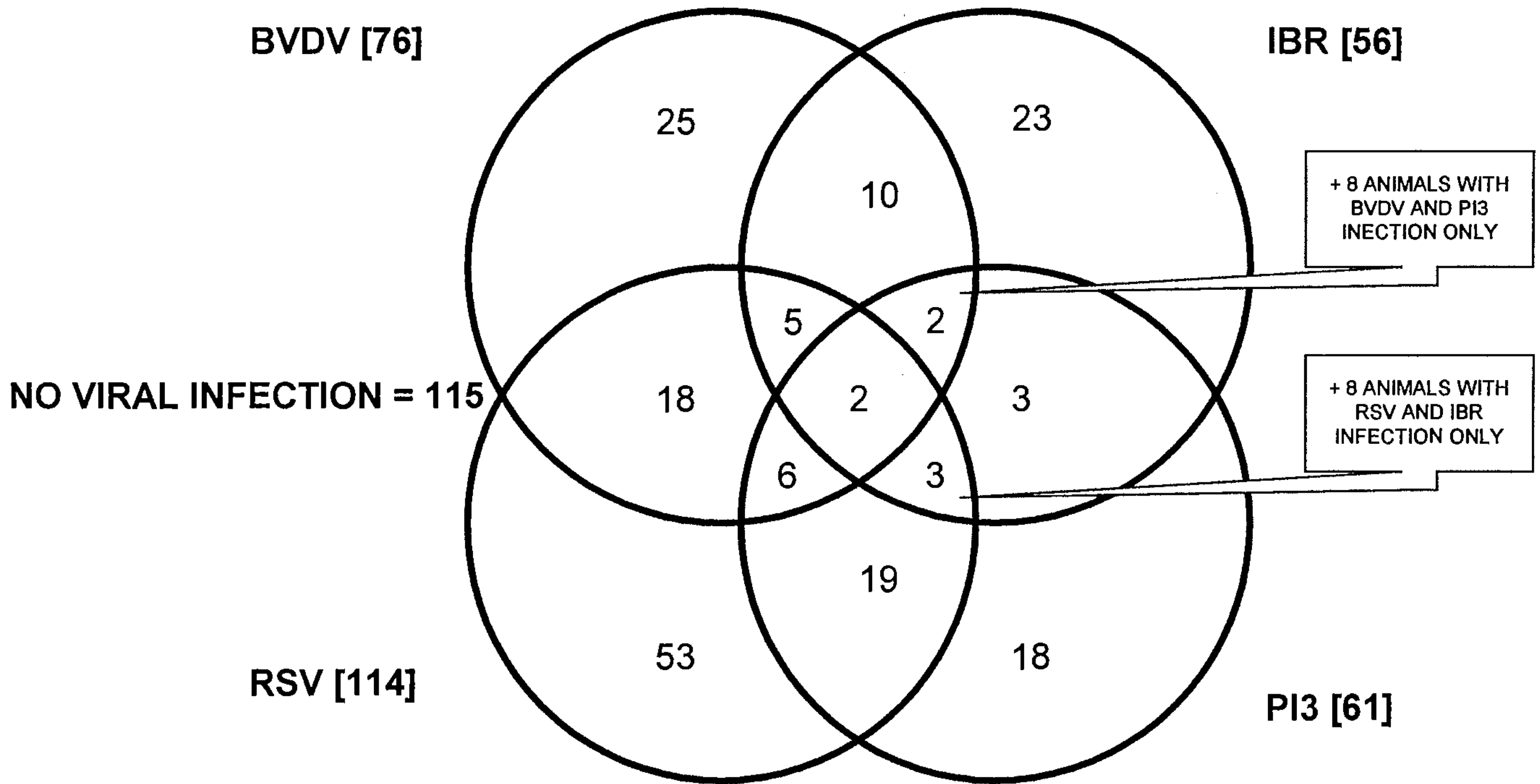


FIGURE 20

multocida was cultured from 2 steers with respiratory disease and 3 steers with lameness. Other *Pasteurella* spp were isolated from 4 steers with fever at entry, 1 steer with respiratory disease and 1 steer with lameness. Of the 13 steers with fever at entry from which *P haemolytica* was isolated, viral infections were diagnosed in 12. The specific viral infections diagnosed in these animals are described in the following section on virology results.

There were insufficient isolates of *P. haemolytica* from sick animals available for typing to make any meaningful interpretation. The single isolate typed was different to the isolated from dead animals. These results are described in a later section describing the bacteriology conducted on dead animals and are listed in detail in Appendix 3.

(iv) Virology examinations in sick and febrile animals

Specimens were available for virology examinations from 318 of the 359 cases of sickness. One or more viral infections were diagnosed (by either virus isolation and/or seroconversion) in 64% (204/318) of these sick cattle. The rates of infection in sick animals with the 4 viruses were: BVDV 24% (77/318), IBR virus 19% (59/318), PI3 virus 19% (61/318) and RSV 36% (114/318) respectively. BVDV was isolated from sick cattle on 6 occasions and IBR was isolated 14 times. PI3 virus and RSV were not isolated from any of the swabs from sick animals. When expressed as an incidence (as a proportion of only susceptible animals), the rates of infection with the viruses were BVDV - 68%, IBR - 20%, PI3 - 43%, RSV - 53%. These rates were similar to those encountered in the sentinels, viz, 68%, 29%, 48% and 57%.

There were single viral infections in 37% (119/318) of sick cattle and infection with 2 viruses in 21% (66/318). Concurrent infection with 3 viruses occurred in 5% (16/318) of these animals, while less than 1% (2/318) were infected with all 4 viruses at the same time. The combinations of viral infections in sick cattle are depicted in Figure 20.

Of the 76 sick animals with BVDV infection, there were 25 infected with BVDV alone, 18 dual BVDV and RSV infections, 10 BVDV and IBR infections, 8 BVDV and PI3 infections, 6 BVDV, PI3 and RSV infections, 5 BVDV, IBR and RSV infections, 2 BVDV, IBR and PI3 infections and 2 BVDV, IBR, PI3 and RSV infections.

In the 56 sick animals with IBR infections there were 23 single IBR

infections, 8 IBR and RSV infections, 3 IBR and PI3 infections and 3 IBR, PI3 and RSV infections as well as the previous combinations with BVDV.

In the 61 sick animals with PI3 infections there were 18 single PI3 infections and 19 PI3 and RSV infections as well as the combinations of infections described previously.

In the 114 sick animals with RSV infections there were 53 single RSV infections as well as the combinations of infections listed above.

The majority of animals in which a viral infection was diagnosed were affected with either fever (43%; 136/318) or respiratory disease (33%;103/318). Viral infections were also diagnosed in animals with lameness, gastroenteritis and illthrift.

The majority of BVDV and IBR virus isolations were made from animals with respiratory disease. There was a diagnosis of pneumonia in 4 of the 6 animals from which BVDV was isolated. The other 2 isolates came from cases of lameness and fever. Two of the animals from which BVDV was isolated were probably persistently infected carriers. IBR virus was isolated from 8 cases of pneumonia, 4 animals with fever (1-6 weeks after entry), one animal with conjunctivitis and one animal with lameness and illthrift.

There was a positive association between the occurrence of respiratory disease and IBR infection over all groups of cattle (relative risk 1.97 with 95% confidence limits 1.23-3.18, $p < 0.01$). This positive association between the occurrence of respiratory disease and IBR virus was present with both IBR infections alone and also when IBR was combined with RSV infection. The significant association between IBR infection and respiratory disease was limited to 2 feedlots. There was no significant association between respiratory disease and any of the other multiple viral infections. However, the numbers in the groups of animals with multiple infections were small (range from 8 to 33) and this limited the power of any statistical analysis. There were no other significant associations between the type of illness and a viral infection when the analysis was conducted across all groups in all feedlots. However, when analyses were conducted across all groups within individual feedlots, there were also significant associations with BVDV infections and respiratory disease ($p = 0.014$) and with BVDV (1 feedlot), IBR (1 feedlot) and RSV (2 feedlots) infections and fever at entry.

Of the 21 steers with *P haemolytica* infections, all 21 were susceptible to IBR virus, 11 were susceptible to BVDV, 9 to RSV and 4 susceptible to PI3. Sixteen of these steers were shown to have been infected with one or more viruses. A diagnosis of BVDV infection was subsequently made in all 11 susceptible animals, alone, in 5 cases, with IBR in 3 cases, with RSV in 2 and with both PI3 and RSV in 1 animal. There were 4 animals infected with RSV alone and 1 animal with RSV and PI3.

Four of the eight animals infected with *P multocida* were shown to have been infected with one or more viruses. Three of these animals were infected with BVDV (1 alone, 1 with RSV and 1 with both RSV and PI3) while the other was infected with IBR virus.

(b) Investigations of Causes of Death.

(i) Animals which died in the feedlots.

During the course of the project, post mortem/laboratory examinations were conducted on 908 animals. Six of these deaths were sentinel animals, 47 were animals in surveillance groups and 861 were from the general feedlot population. The death rate in surveillance pens was found to be 0.9% (47 animals), similar to the rate of 0.7% found in the original Phase I survey.

There were 6 animals recorded as having died on the day of entry with the remaining mortalities ranging up to 332 days on feed (the number of days animals had been on feed was recorded for 843 animals). The pattern of mortalities over time for each feedlot is shown in Figure 21. For young cattle, (i.e., 18 months or less), the mean number of days on feed at death was 42 while for cattle older than 18 months, they had been on feed for a mean of 84 days to death. The mean body weight at death was 378 kgs with a range from 95 to 850 kgs (n = 559).

Pathological changes were described in 552 animals. There were a further 356 deaths in which specific lesions were not recorded. These were mostly post mortems conducted by feedlot personnel where a probable diagnosis was established without the completion of all data recording. Samples were submitted from 598 postmortems for laboratory examination. From these, 542 had samples submitted for bacteriology, 269 for virology and 422 for histopathology.

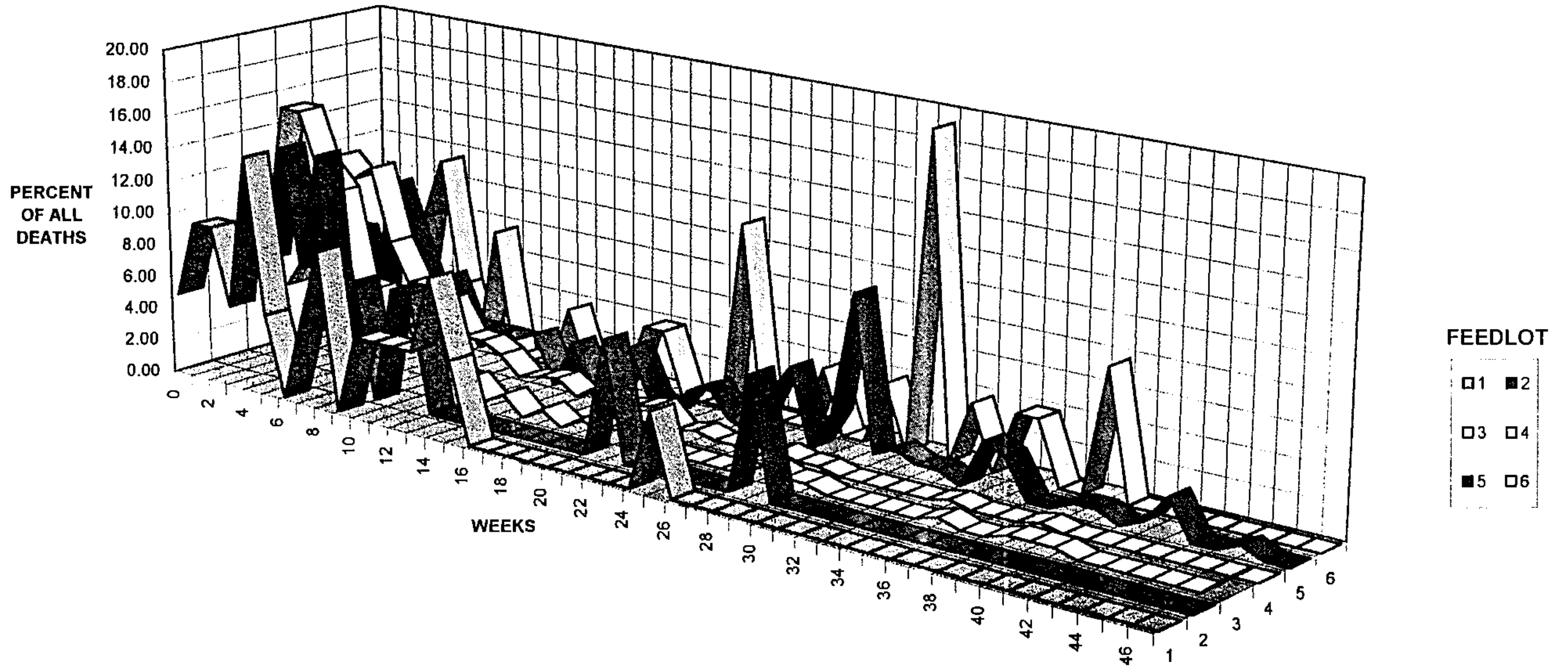


Figure 21

The suspected cause of death based on clinical signs and post mortem observations are listed for each feedlot in Table 7 and depicted in Figure 22. The major categories of death described were respiratory disease (53%), gastro-intestinal (12%), lameness (6%), feed related problems (5%), injury (4%) and unknown (5%). Most of the deaths, and especially those due to respiratory disease, occurred in the first 90 days in the feedlot. Up until this time, there was a higher proportion of cases of BRD but later in the feeding period, other causes of death were more common (Figure 23). The apparent rise in deaths at about 180 days was due to an upsurge in feed-related disorders, predominantly acidosis in one feedlot.

TABLE 7:
CAUSES OF DEATHS IN EACH FEEDLOT

DISEASE	FEEDLOT						
	1	2	3	4	5	6	TOTAL
FEED RELATED	1		1	26	14	5	47
FOOT CONDITION			4	27	23	3	57
GASTROINTESTINAL	8	4	35	7	49	7	110
HEAT STRESS			2		3		5
INJURY			5	14	17		36
'NON DOER'		1	3	3	7		14
NEUROLOGICAL	3		2	11	5		21
OTHER	2	2	37	17	13	3	74
RESPIRATORY	17	8	198	21	36	13	482
UNKNOWN	2		2	3	7	2	43
URINARY	2		1		1	6	19
TOTAL	35	15	290	345	184	39	908

49

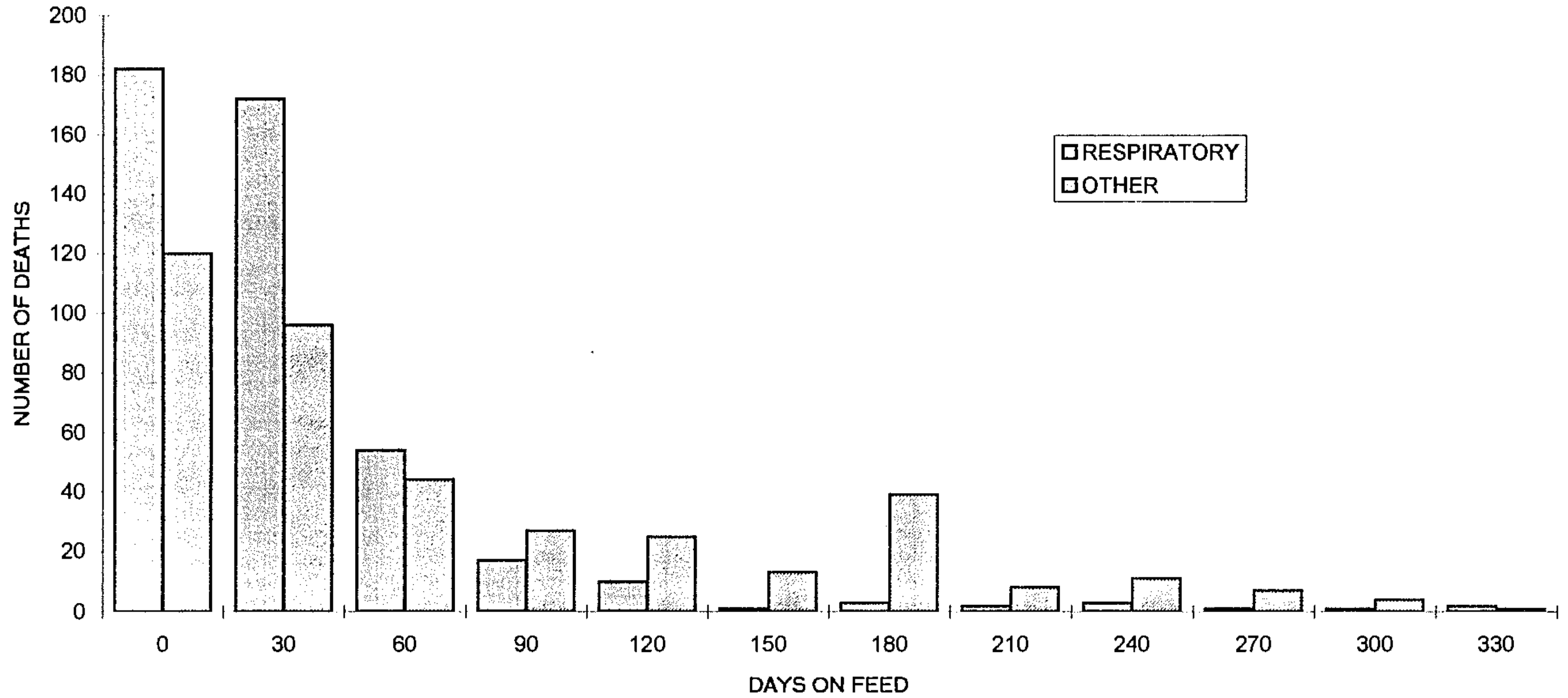


Figure 23

Changes were described in the respiratory tract of 440 animals. Of these, there were 384 with pneumonia, 183 with pleurisy, 134 with lesions in the larynx (65 cases) or trachea (69 cases), 106 with lesions also involving the heart, 62 with involvement of the bronchial lymph nodes and 23 with lesions in the nostrils.

There were 280 animals with abnormalities described in the gastrointestinal tract. Liver changes were found in 157, 123 had abnormalities in the small intestine, rumen lesions were present in 68, abomasal lesions in 41, there were lesions in the mesenteric lymph nodes of 38, splenic disorders in 31, lesions in the large intestine in 24 animals, gall bladder abnormalities in 16, lesions in the mouth in 9 and a single animal had an oesophageal lesion.

Ninety seven animals were found to have abnormalities of the urogenital tract, of which there were 87 with kidney lesions, 18 with bladder changes and 11 with lesions in the ureters.

Disorders of the locomotor system were described in 41 animals. Muscle lesions were found in 20, with joint lesions in 10 and abnormalities of the feet in 10 animals.

Neurological changes were found in 7 animals, each with lesions in the brain, meningitis in 3 and spinal lesions in 1 animal. No eye abnormalities were described. Skin disorders were found in 25 animals at post mortem.

Bacteriology from dead animals - Fresh tissue samples were collected at autopsy from 542 of the 908 deaths recorded. A total of 1,468 bacterial cultures were performed on the specimens collected. The range of bacteria cultured from these 542 dead animals are listed for each feedlot in Table 8.

There were no significant bacterial isolates from 67% (984/1468) of the specimens (Figure 24). *Pasteurellae* were cultured from 12% (176) of the tissues collected. In contrast to the isolates from sick cattle, the relative proportions from autopsy specimens were *P multocida* 63% and *P haemolytica* 37%. The isolation rates for other bacteria from autopsied animals were *A pyogenes* 5.2% (76), *Salmonella* spp 5.4% (79), and various other bacteria, 10.4% (153).

When the culture rates are examined on an individual animal basis, rather than as individual specimens, there were no significant bacterial isolates from 56% (303/542) of the animals. Approximately two thirds of these animals had not been treated with antibiotics. *Pasteurellae* were cultured from 19% (104) of the dead animals sampled. In contrast to the isolates from sick cattle, the relative proportions from dead cattle were *P multocida* 62% and *P haemolytica* 38%. The number of autopsied animals from which other bacteria were isolated were *A pyogenes* 8% (41), *Salmonella* spp 5% (27), and various other bacteria, 12% (67/542).

Pasteurella spp were most commonly isolated from the respiratory tract. Of the 79 *Salmonella* spp isolated from 27 autopsies, 53% (42) were isolated from the gastrointestinal tract, 17.7%(14) from the respiratory tract, 15.2% (12) from the liver, 6.3% (5) from kidney, 5.1% (4) from the spleen and 2.5% (2) from pooled tissues.

Representative isolates of *P. haemolytica* and *P. multocida* were characterised and typed. These results are presented in Appendix 3. Briefly, the isolates of *P. haemolytica* were found to belong to Biovar H1, with limited phenotypic and genotypic diversity. However, there is doubt whether these isolates are representative of the Australian feedlot population because most of the isolates available and subsequently typed were from 1 NSW feedlot. There was greater phenotypic and genotypic diversity among the *P. multocida* isolates characterised , especially between northern NSW and Southern NSW/Vic feedlots. The significance of these variations remains unknown.

Virology from dead animals - Autopsy material was submitted for virology from 269 animals. BRD cases accounted for 60% (161/269) of these submissions for virology. The next most frequent diagnostic category in the cases submitted for virology was gastrointestinal disease (17% of cases).

A viral infection was diagnosed in 27% (73/269) of the deaths investigated. Of the 73 dead animals in which there was a viral infection identified, 66 were affected with BRD (cases of pneumonia, tracheitis and laryngitis). There were therefore 41% of BRD cases in which a viral infection was confirmed. Of the remaining cases in which a viral infection was confirmed, 3 had enteritis, 1 a generalised infection, 1 with a haemhorragic syndrome and 2 in which there was no specific diagnosis made at autopsy.

TABLE 8:

BACTERIA CULTURED FROM TISSUES OF DEAD ANIMALS IN EACH FEEDLOT

ISOLATE	1	2	3	4	5	6	TOTAL
ACTINOMYCES	3	2	40	17	15		77
ACTINOBACILLUS LIGNIERESII				1			1
BACILLUS ANTHRACIS					3		3
CAMPYLOBACTER JEJUNI					1	1	2
CLOSTRIDIUM PERFRINGENS (CIEP +ve)					1		1
CLOSTRIDIUM NOVYI (FAT +ve)			1		1		2
CLOSTRIDIUM SEPTICUM (FAT +ve)					1		1
CORYNEBACTERIA				6	4		10
E. COLI	1	2	4				7
FUSOBACTERIUM NECROPHORUM		1		14	6		21
HAEMOPHILUS SOMNUS			9	9	8	3	29
HAEMOPHILUS LIKE						2	2
LISTERIA IVANOVII					1		1
PASTEURELLA HAEMOLYTICA	4	2	32	10	13		61
PASTEURELLA MULTOCIDA	2	7	81	13	3	1	107
PASTEURELLA (OTHER SPECIES)			2	3	3	1	9
PSEUDOMONAS AERUGINOSA				2	2		4
SALMONELLA TYPHIMURIUM			54	9			63
SALMONELLA (OTHER SPECIES)	1	4	6	3	1		15
STAPHYLOCOCCI			5	3			8
STREPTOCOCCI			10	9	8	1	28
YERSINIA			1			1	2
NO SIGNIFICANT GROWTH	65	21	279	313	278	57	1013
TOTAL	76	39	524	412	349	67	1467

BACTERIAL ISOLATES FROM DEAD ANIMALS

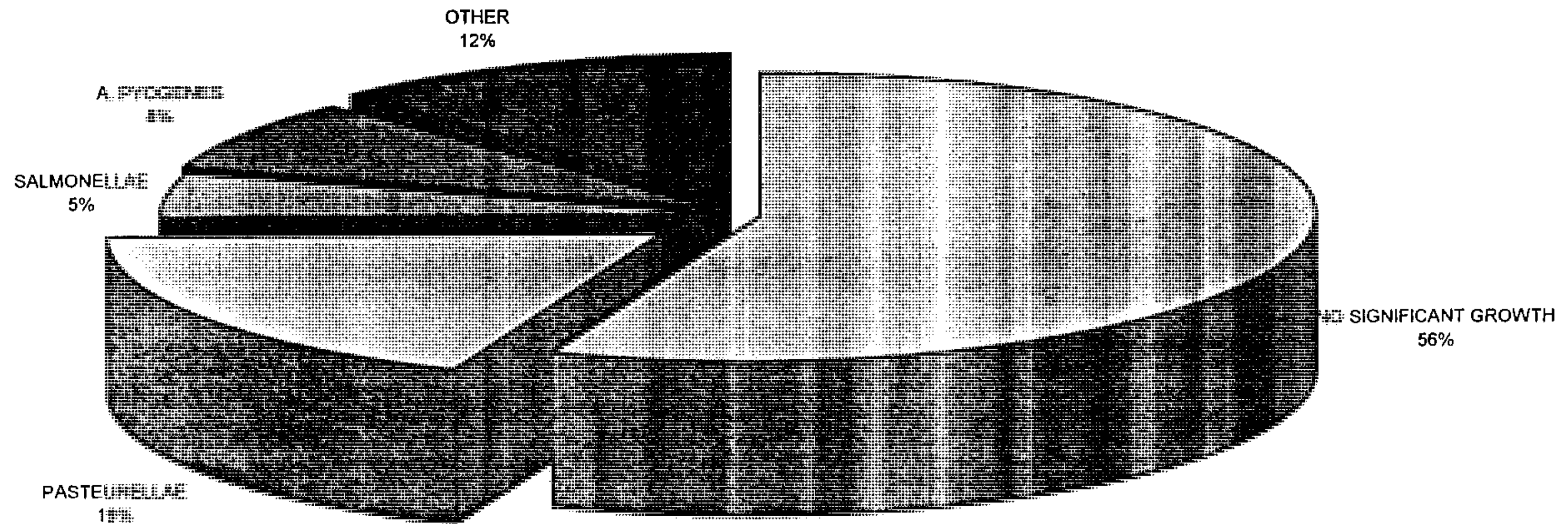


Figure 24

There were 43 diagnoses of BVDV infection, 36 diagnoses of IBR, 1 diagnosis of PI3 infection and one unidentified virus isolated. This unidentified virus was probably an enterovirus. Included in the preceding totals were 8 animals with both BVDV and IBR infections. The viral infections were confirmed by virus isolation in all but 6 occasions. In the latter instance, BVDV was confirmed by antigen ELISA. BVDV (alone) was implicated in 32 BRD cases, IBR (alone) in 25, both viruses in 8 cases and PI3 in one. Respiratory syncitial virus was not isolated from any of the tissues submitted.

Of the 43 BVDV infections confirmed, 40 were from cases of pneumonia and/or laryngotracheitis, 2 were diagnosed as enteritis and 1 case peritonitis. A number of the pestivirus cases with pneumonia also had lesions in other body systems, for example, peritonitis, multiple abscesses, enteritis. Of the 36 IBR cases, 29 were diagnosed as predominantly pneumonia, 4 were laryngitis or tracheitis, there was 1 case of enteritis, 1 of a haemhorragic disorder and 1 case without a specific pathological condition identified. A number of submissions which were identified on the field report as "typical IBR", particularly with laryngitis or tracheitis, were found to be pestivirus infections. There were significant associations between both pestivirus infection and respiratory disease ($p < 0.02$) and IBR virus infection and respiratory disease ($p < 0.01$). There were no other significant associations between a viral infection and cause of death.

The histopathology examinations conducted on the tissues from dead animals revealed a range of lesions consistent with the bacteria and viruses isolated. The PI3 virus isolation came from an animal with severe traumatic (foreign body) reticulo-pericarditis. The histology on tissue samples from this animal did not indicate the presence of any lesions which could be attributed to the PI3 virus infection. There were no changes which were suggestive of infection with RSV in any of the lung samples submitted from dead animals.

A representative subset of the IBR virus isolates was referred to Dr P. Young at the Animal Research Institute, Yeerongpilly for determination of the restriction enzyme profiles for the viral DNA. All isolates were found to be Subtype 2 viruses (BHV 1.2), as commonly found in Australia previously.

(ii) Animals sent for emergency slaughter.

The practise of sending animals for slaughter was adopted by some feedlots as a salvage procedure to avert the need for treatment and long withholding periods. There were 12 animals slaughtered from surveillance pens but the practise was sometimes more widespread in some feedlots and the number of animals slaughtered prematurely may have influenced the number of sick animals reported. Virology investigations were conducted on 5 of these animals prior to dispatch, during the initial stages of their illness. BVDV infection was diagnosed in 1 animal and dual PI3/RSV infections in another case. No viral infection was identified in the other 3 animals. No samples were obtained from any of the 12 animals at slaughter.

(c) Examination of Animals at Slaughter

An attempt was made to examine as many animals from surveillance pens as possible when they were finally sent for slaughter, to check for gross pathology and to collect blood samples to complete the virological testing.

From the 5306 animals in surveillance pens, 4097 animals examined at slaughter for lesions in the lung, pleura, heart, liver, peritoneum and kidney. Lesions were observed in 11% (3111) of animals with 98% of these graded as mild (ie less than 25% of the organ was affected). The results of these examinations are shown for each feedlot in Figures 25 - 30. There were marked differences between feedlots on the number and type of lesions found at slaughter. Most of the feedlots had a moderate prevalence of abnormalities in the lungs and pleura. The frequency of changes in the liver, especially due to liver fluke infestation, was slightly more variable and were not reported at all in Feedlot 1. Kidney abnormalities were common in 3 of the feedlots but were found at a low prevalence, or were absent, in the other 3 feedlots.

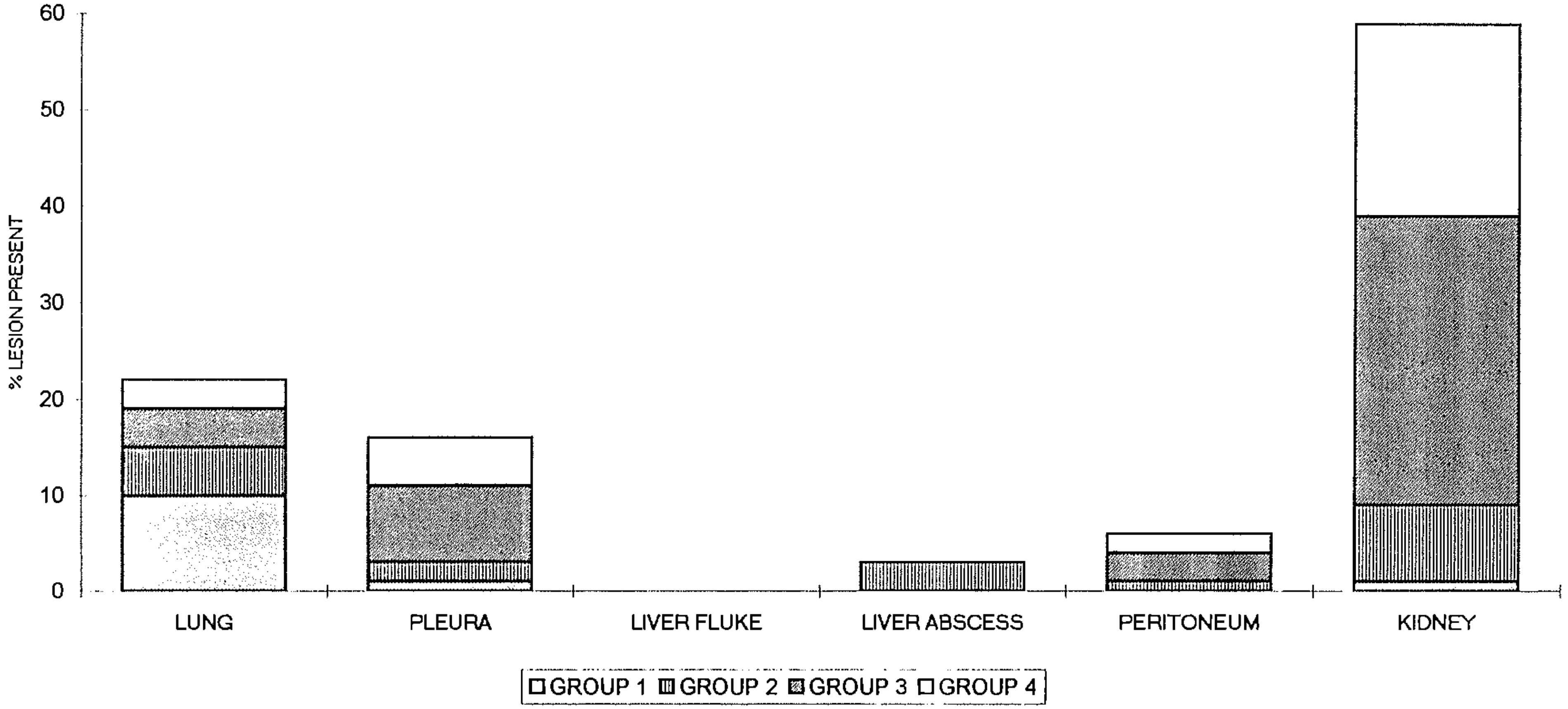


Figure 25

LESIONS FOUND AT SLAUGHTER IN SURVEILLANCE GROUPS   FEEDLOT 2

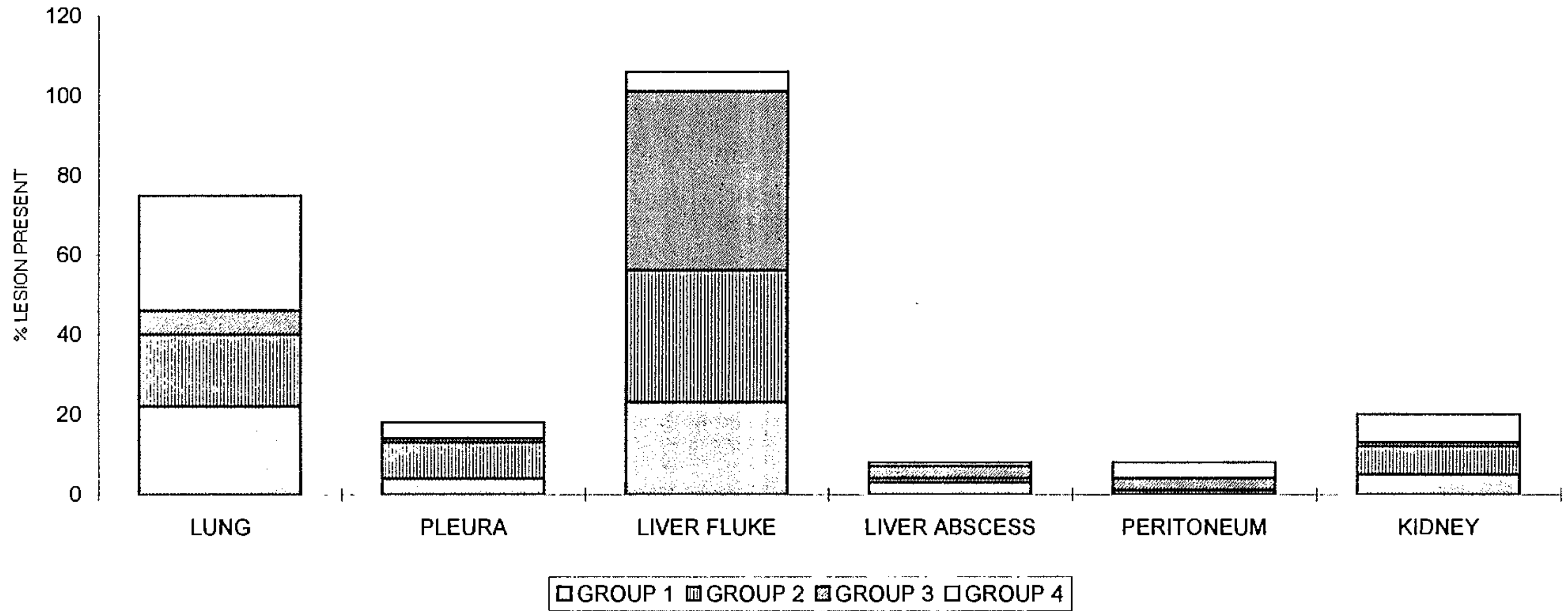


Figure 26

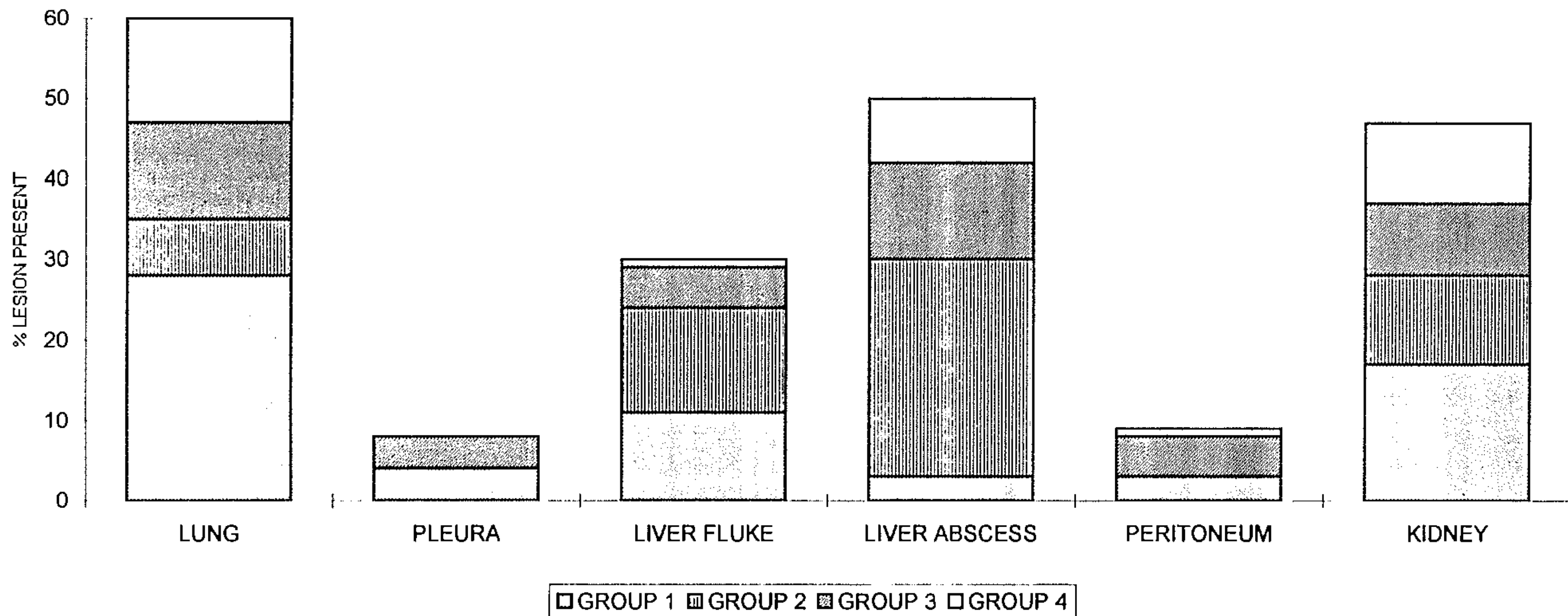


Figure 27

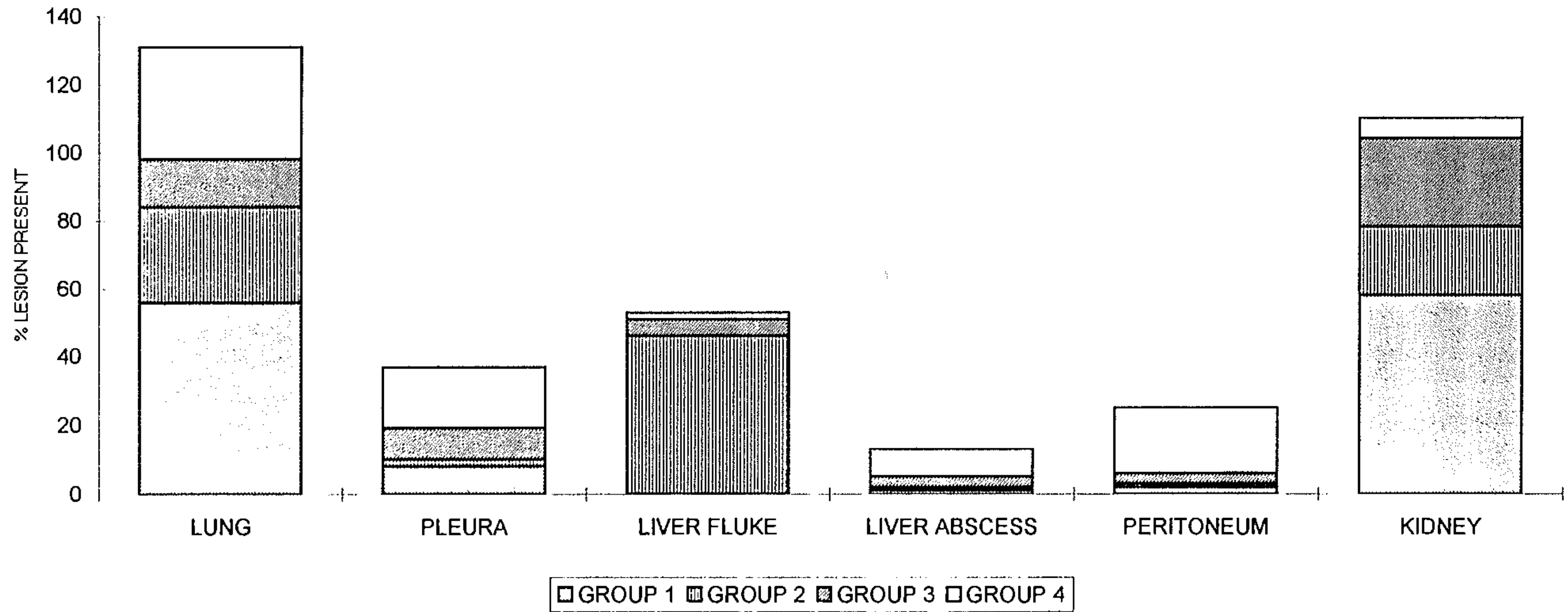


Figure 28

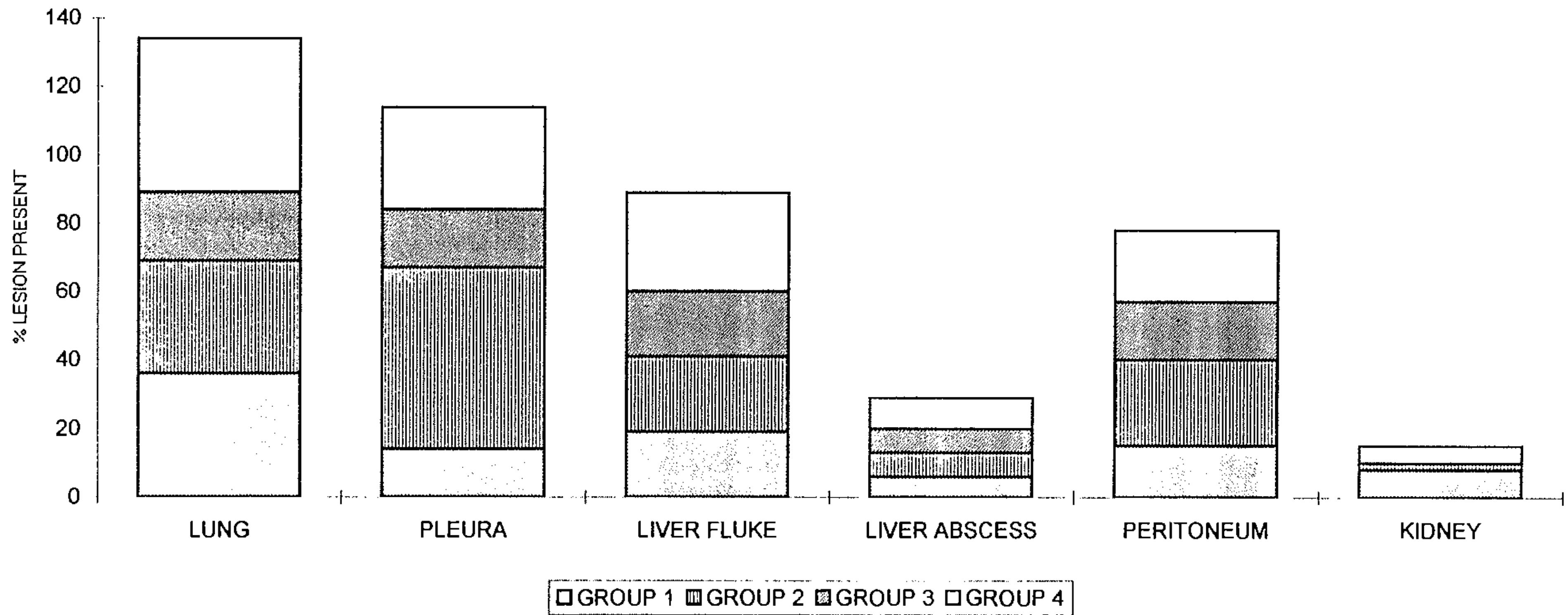


Figure 29

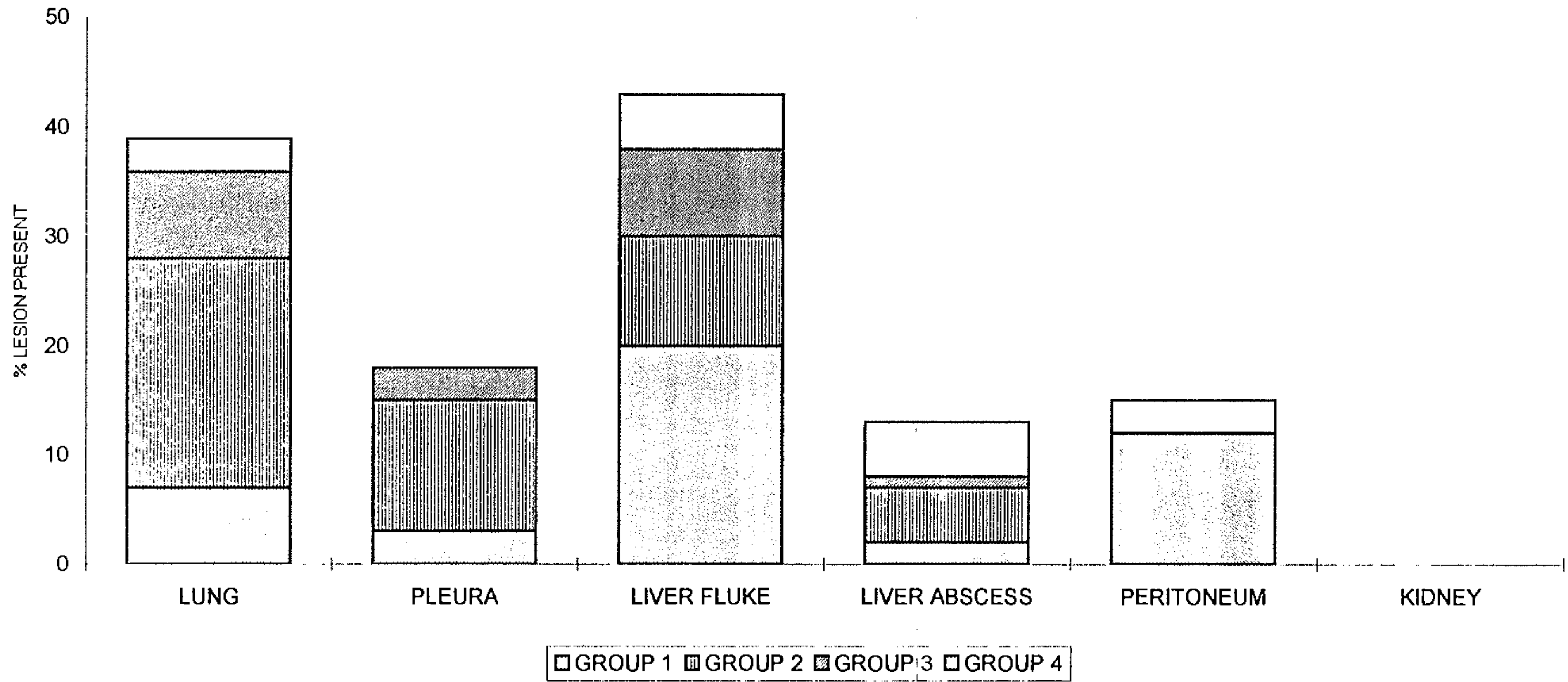


Figure 30

Discussion and Conclusions

During the course of the project, the feedlot mortality and morbidity results were within the ranges expected of a normal feedlot (ie one not experiencing a major disease problem) and were similar to those reported during the Phase 1 project disease survey.

With the exception of fever at entry, BRD was still found to be the most frequently diagnosed disease condition in most feedlots. Infections with each of the 4 viruses were common in sick cattle, either individually or in various combinations. The small numbers of sick cattle in most groups limited the capacity to apply an intensive statistical analysis of the relative importance of the 4 viruses studied. However, across all feedlots, IBR infection alone or combined with RSV infection was positively associated with illness due to BRD. When results from individual feedlots were examined, there were also significant associations of BVDV infection with respiratory disease and BVDV, IBR and RSV infections with fever at entry. The frequency and complexity of multiple infections and interactions between both viruses and bacteria and the intensity of sampling in this study limited the ability of this study to identify the role of viruses such as BVDV as predisposing agents to other infections.

There was no significant relationship between fever at entry and subsequent episodes of disease as there were 122 animals with fever at entry and only 9 were diagnosed with a subsequent illness.

The majority (87%) of cattle entering a feedlot were susceptible to IBR virus and 61% of animals were still susceptible after 6 weeks in the feedlot. IBR infections later during the feeding period were not associated with the occurrence of respiratory disease in this study. This would suggest that there are perhaps other agents or factors which interact with IBR virus infections to precipitate clinical respiratory disease.

Typing of the IBR virus isolates from this project indicated that they were similar to isolates previously obtained in Australia and all belonged to the 2(a) subgroup, that is, those commonly associated with the IBR/IPV syndrome. An interesting feature was that all of the isolates from one feedlot had an identical

restriction enzyme profile, even though they were made over a period of approximately 18 months. This would suggest that, rather than new viruses entering with different batches of animals, cattle become infected with this particular strain of virus which persists in this feedlot.

Genotyping of IBR isolates has shown that the more virulent subtype 1.1 viruses that are found in North American feedlots do not appear to occur in Australian feedlots. Consequently, the importation of a live IBR vaccine would present a great risk to the Australian cattle population unless the virus is carefully characterised.

Approximately two thirds of cattle entering feedlots are apparently immune to BVDV on entry but there can be still substantial numbers of susceptible cattle in some pens. This virus is readily spread between animals and most of the susceptible animals become infected with pestivirus in the first few weeks in the feedlot, coinciding with the peak of BRD cases.

Feedlot cattle quickly become infected with PI3 and RSV viruses but these infections do not appear to be clearly associated with disease.

There was a wide variation between groups in susceptibility on entry to all 4 viruses and this was not related to age at entry to the feedlot. The seroconversion rate to all 4 viruses varied greatly both in the first 6 weeks and between 6 weeks and slaughter and this was not restricted to an individual feedlot or related to the length of time animals were on feed.

The results of this study show that *P haemolytica* is cultured more frequently from sick cattle soon after entry to the feedlot than *P. multocida* but most of the isolates come from febrile animals rather than animals with respiratory disease. In comparison to the North American experience, a major role for *P haemolytica* as the initiating factor in BRD or fever at entry cannot be substantiated by the results of this study.

BRD was identified as the cause of 53% of deaths. BVDV and IBR were isolated from post mortem material with similar frequency and were both shown to be significantly associated with deaths from respiratory disease. Further, the prevalence and role of viruses in feedlot deaths may be underestimated due to the potential delay between the onset of a viral infection and the time of death, and also the suitability specimens for virus isolation. While a highly labile agent

such as RSV could be significantly under-represented, the lack of indicative lesions at histopathology would suggest that this virus may not be a major factor in feedlot deaths in Australia.

Among the bacteria, *P multocida* was much more common than *P haemolytica*, in autopsy material. Other bacteria commonly isolated were *Salmonella* spp and *A pyogenes*.

When the project animals were examined at slaughter, liver damage causing condemnations occurred with relatively high frequency. Careful sourcing of cattle from liver fluke free country could reduce costs of both drenching for liver fluke as well as reducing the number of liver condemnations at slaughter.

As most of the illness in lot-fed cattle occurs in the first 4-6 weeks from the time of entry, control measures need to be effective from the time of entry to the feedlot, or even from the time of departure from the property of origin, when cattle begin to be exposed to a different range of pathogens and stress. As it usually takes animals at least three weeks to develop effective immunity by natural exposure or after vaccination, vaccination on entry to the feedlot will not provide optimal control of BRD. Vaccines and other control measures will preferably need to be delivered to animals on the property of origin or while still on pasture and have been subjected to minimal mixing with animals of different origins. A sufficient lead-time will be required to provide optimal protection. Measures to assist cattle adapt to the changed environment are also likely to be of benefit.

Achievement of Objectives

This project clearly achieved the objectives which were set at the commencement, namely, to determine the infectious causes of respiratory disease and the causes of death in feedlot cattle in Australia. The four key viruses, BVDV, IBRV, PI3 and RSV were each shown to be present in Australian feedlots. At least 2 of these (BVDV and IBR virus) were shown to have a significant role in the BRD complex. The relative significance of *Pasteurella haemolytica* and *Pasteurella multocida* was established in both the "shipping fever" syndrome and deaths associated with BRD.

The time of infection with the infectious agents was also determined. This information should be valuable for the design of suitable control strategies.

Intellectual Property

While this is a substantial body of information and "know how" which has been gained during the course of this project, there is none that could be considered commercially sensitive and needing protection. All data from this project should be considered to be in the "Public Domain", at least within the cattle industries. This data should, however, be handled with a degree of commercial sensitivity as some of the content has the potential to cause an adverse reaction in certain markets. Some of the bacteria and viruses isolated have been retained and are a potentially valuable resource for further study and vaccine development. These micro-organisms are the joint property of the organisations which provided funding. Selected *Pasteurella* isolates have been provided to CSIRO Parkville for such purposes.

Financial Statement

The Meat Research Corporation contributed $200,000 which was distributed to EMAI ($80,000) and the Regional Veterinary Laboratories at Wagga, Armidale and Toowoomba ($40,000 each) to assist in the conduct of laboratory examinations. The contribution from MRC was used to employ laboratory staff, purchase laboratory consumables and meet the cost of travel.

The research organisations (NSW Agriculture and Queensland Department of Primary Industries) contributed professional and laboratory staff time, materials and laboratory overheads (estimated cost $200,000). These organisations also contributed the cost of professional and technical staff involved in property visits, record keeping, data analysis, writing reports and attending meetings (estimated value $100,000). The collaborating ALFA feedlots sourced suitable cattle, yarded and sampled cattle, kept records, conducted autopsies, attended meetings and liaised with researchers (estimated value $100,000).

Impact of Research in 1993

The research has had the following results:

- Confirmed the original mail questionnaire survey data regarding rates of illness and death in feedlot cattle in Australia.
- Confirmed that the viral pathogens commonly described overseas are present in Australian cattle.
- Provided data on the relative importance of *Pasteurella* species.
- Provided representative isolates of significant bacterial and viral pathogens.
- Provided data on the epidemiology of the viral pathogens in Australian feedlot environments.
- Enhanced contact and communication between feedlot management and diagnostic laboratories, disease control authorities and research groups.

Impact of Research in 1998

In five years we anticipate that this research will have had the following outcomes:

- Reduced the quantities of antibiotics used and reduced the risk of antibiotic residue violations.

- Gained acceptance of management routines such as "backgrounding" and "pre-boosting" to improve the adaptation of cattle to the feedlot environment and reduce the risk of disease.
- Significantly reduced rates of illness and mortality in feedlot cattle.
- Achieved community recognition of the improvement of the health and welfare of feedlot cattle.

Acknowledgments

We wish to gratefully acknowledge the co-operation of the managers and staff of the participating feedlots and their consulting veterinarians. The staff of the Regional Veterinary Laboratories and the EMAI Virology laboratory is appreciated.

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APPENDIX 1A

Form 1 DISEASES OF FEEDLOT CATTLE

LOT HISTORY:

LOT NUMBER:			NUMBER IN LOT:
DATE ARRIVED:			DATE PROCESSED:
WHY SELECTED:			
SOURCE: SALEYARD: ☆			DIRECT FROM PROPERTY: ☆
ORIGIN:			
BREED:			SEX:
HOW LONG ON TRUCK PRIOR TO APPROVAL:............................ hrs.			
ANY BACKGROUNDING?			
PROCESSING	NO	YES	
WORM DRENCH			(type)
FLUKE DRENCH			(type)
LICE TREATMENT			(type)
5 IN 1			(type)
ANTIBIOTIC			(type)
IMPLANT			(type)
VIT AD & E			
ANTIBIOTIC IN FEED			(type)
AVERAGE WEIGHT:			
NUMBER WITH HIGH TEMPERATURE:			
NUMBER PULLED:			
DATE SLAUGHTERED:			NO. SLAUGHTERED:
DAYS OF FEED:			
AVERAGE DAILY GAIN:			

APPENDIX 1B

Form 2

FEEDLOT DISEASES PROJECT
- Data collection at cattle processing (on entry)

FEEDLOT:

Lot No:	Date 1st sample:	Date 2nd sample:
Max. Daily Environmental Temp:		Average age:
Breed:	Average Weight:	Body condition:
No. in lot:	Origin:	Area (*if known*):

No	Trial Tag	Ear Tag	Origin Tail Tag.	Rectal Temp.	Body weight	Comment
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

SAMPLING PROCEDURE

- *Randomly identify sentinel animals by dividing number in lot by 20 (=n) and sample every nth animal if clinically normal and with temperature less than 40.5°C.*
- *If sick or high temperature, sample as for sick animals (Form 2) and select the next normal animal as a sentinel.*
- *Take blood sample, pour off serum and freeze.*
- *Bleed these sentinel animals again after six (6) weeks and send both bloods with a copy of this form to EMAI.*
- *Bleed 5 animals at each sampling for Vit A. Hold paired samples frozen* at RVL.

APPENDIX 1C
Form 3

FEEDLOT DISEASES RESEARCH PROJECT
- High Temperatures at Processing
- Sick Animals during Surveillance Period

FEEDLOT:	LOT NO:

No	Ear Tag No.	Date 1st Bleed	Date 2nd Bleed	Weight	Temp.	*Clinical diagnosis	Treatment	Result
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

*Clinical diagnosis: eg. Respiratory, Scouring, Bulling, Not eating, Feet.
#Result: eg. Return to pen - Cull, Re-treat, Death.

SAMPLING PROCEDURE:

- *Identify sick animals with extra individually numbered tag.*
- *Sample animals with temperatures > 40.5°C at the time of processing - maximum 10*
- *Sample sick animals during surveillance period - maximum 10/week*
- *Take nasal and ocular swabs at first sampling - into PBG and STM - may combine swabs from both sources in one media. CHILL - DO NOT FREEZE.*
- *Send blood sample and on clot and PBS swab on clot to Elizabeth Macarthur Agricultural Institute (EMAI) with a copy of this form.*
- *Send faecal sample blood sample for Vitamin A, and STM swab to Regional Veterinary Laboratory (RVL) with a copy of this form.*
- *Bleed again in 3 weeks and send sample on clot to EMAI with a copy of this form.*

To EMAI
Woodbridge Road,
Menangle

RVL ....

Signed: ....

Date: ....

APPENDIX 2

SURVEILLANCE PEN SUMMARY - FEEDLOT 1.

Surveillance Group	1	2	3	4	5
Pen No	307	359	425	508	527
Date Arrived	16/11/91	23/03/92	21/07/92	02/01/93	05/03/93
Date Processed	29/11/92	30/03/92	27/07/92	11/01/93	12/03/93
Number in lot	287	270	207	304	189
Source Saleyard/Direct	MX	MX	DR	DR	DR
Origin	S QLD N NSW	QLD & NSW	MOREE	FN QLD	SW QLD
Breed	B	B	B	BxI	B
Sex	S	S	S	S	S
Travelling Time (Avg Hrs)	12	6	6	14	8
Backgrounding	N	N	N	N	N
Avg Wgt on Entry (Kg)	416	418	146	212	273
Avg Body Score on Entry (1-5)	4	4	3	4	4
Avg Age on Entry (Mths)	24	24	18	18	18
No with High Temp on Entry	22	10	29	4	9
No Pulled	25	21	21	15	9
No Died	1	3	1	0	1
No Slaughtered	282	268	205	265	185
Days on Feed	102	143	125	94	83
Average Daily Gain (Kg/day)	1.77	1.68	1.7	1.7	1.3

APPENDIX 2

SURVEILLANCE PEN SUMMARY - FEEDLOT 2.

Surveillance Group	1	2	3	4
Pen No	89	110	193	30
Date Arrived	08/01/92	10/03/92	17/09/92	03/11/92
Date Processed	14/01/92	17/03/92	22/09/92	24/11/92
Number in lot	200	200	200	198
Source Saleyard/Direct	DR	SY	DR	DR
Origin	DUBBO	QLD/NSW	N NSW / S QLD	N NSW/ S QLD
Breed	B	B	B	B
Sex	S	S	S	S
Travelling Time (Avg Hrs)	11	10	8	8
Backgrounding	N	N	N	N
Avg Wgt on Entry (Kg)	451	426	425	440
Avg Body Score on Entry (1 - 5)	4	3.8	4	4
Avg Age on Entry (Mths)	27	24	24	24
No with High Temp on Entry	3	8	8	12
No Pulled	31	17	8	10
No Died	1	2	1	2
No Slaughtered	199	197	196	193
Days on Feed	161	136	164	183
Average Daily Gain (Kg/day)	1.5	1.82		1.18

APPENDIX 2

SURVEILLANCE PEN SUMMARY - FEEDLOT 3.

Surveillance Group	1	2	3	4
Pen No	792	868	892	925
Date Arrived	15/01/92	30/06/92	25/09/92	18/01/93
Date Processed	23/01/92	08/07/92	29/09/92	20/01/93
Number in lot	239	100	389	198
Source Saleyard/Direct	SY	SY	SY	DIR
Origin	S NSW /N NSW	MX	MX	QDI
Breed	B	B	B	B
Sex	S	S	S	S
Travelling Time (Avg Hrs)	8	7	6	1
Backgrounding	N	N	N	N
Avg Wgt on Entry (Kg)	284	279	274	450
Avg Body Score on Entry (1 - 5)	3			
Avg Age on Entry (Mths)	12	12	12	24
No with High Temp on Entry	5	9	10	2
No Pulled		6	5	36
No Died	2	1	6	1
No Slaughtered	236	94	308	87?
Days on Feed	91	95	179	147
Average Daily Gain (Kg/day)	1.3	1.49	1.53	

APPENDIX 2

SURVEILLANCE PEN SUMMARY - FEEDLOT 4.

Surveillance Group	1	2	3	4
Pen No.	49 Summer	49 Autumn	1	29
Date Arrived	3/2/92	-	27/7/92	10/10/92
Date Processed	7/2/92	1/5/92	30/7/92	15/10/92
Number in Lot	138	150	147	129
Source Saleyard/Direct	Mx	Direct	Mx 50/50	Mx
Origin	W VIC	STH NSW NW VIC	W VIC SW NSW	SA, VIC
Breed	AA/HF	AA/HF	AA/MG/HF	HF/AA/MG/SH
Sex	S	S	S	S
Travelling Time (Avg Hrs)	3.5	5	5.5	6
Backgrounding	NO	NO	NO	NO
Average Weight On Entry (Kg)	254	267	271	420
Average Body Score on Entry (1-5)	2	2	2	2
Average Age on Entry (Mths)	12	11	11	18
No. With High Temps On Entry	13	4	15	10
No. Sick in Feedlot	12	3	17	16
No. Died	3	0	2	0
No. Slaughtered	127	150	144	127
Days on Feed	81	89	77	196.5
Average Daily Gain (Kg/day)	1.3	1.4	1.84	1.3

APPENDIX 2

SURVEILLANCE PEN SUMMARY - FEEDLOT 5.

Surveillance Group	1	2	3	4
Pen No.	B14/B30/B15	A18	B23	A10
Date Arrived	Sept/Oct'91	6/2/92	1/5/92	30/7/92
Date Processed	12/11/91	10/2/92	5/5/92	5/8/92
Number in Lot	311	330	299	290
Source Saleyard/Direct	Mx 50/50	Mx 30/70	Mx 50/50	Mx 30/70
Origin	STH NSW/ W.VIC	VIC, SW NSW, SE SA	NW VIC, STH NSW	NTH VIC STH NSW
Breed	MG/AA	MG/AA	MG/AA	MG/AA
Sex	S	S	S	S
Travelling Time (Avg Hrs)	5	5	3.5	3
Backgrounding	NO	NO	NO	NO
Average Weight On Entry (Kg)	469	420	378	452
Average Body Score on Entry (1-5)	3	3	2	3
Average Age on Entry (Mths)	24	18	18	24
No. With High Temps On Entry	4	NIL	30	3
No. Pulled	2	11	2	1
No. Died	2	5	1	9
No. Slaughtered	308	323	293	268
Days on Feed	235	265	329	291
Average Daily Gain (Kg/day)	1.22	0.95	0.89	0.99

APPENDIX 2

SURVEILLANCE PEN SUMMARY - FEEDLOT 6.

Surveillance Group	1	2	3	4
Pen No	NA	NA	NA	NA
Date Arrived	10/01/92	13/04/92	25/07/92	12/10/92
Date Processed	14/01/92	14/04/92	28/07/92	13/10/92
Number in lot	126	119	149	137
Source Saleyard/Direct	SY	DR	MX	DR
Origin	S NSW / VIC	VIC / LOCAL	CENT NSW	YOUNG
Breed	B	B	B	B
Sex	S	S	S	S
Travelling Time (Avg Hrs)	18			12
Backgrounding	N	N	N	N
Avg Wgt on Entry (Kg)	410	389	396	403
Avg Body Score on Entry (1 - 5)				
Avg Age on Entry (Mths)	20	20	20	20
No with High Temp on Entry	1	1	0	1
No Pulled	1	3	6	11
No Died	1	2	0	0
No Slaughtered	109	116	141	137
Days on Feed	266	240	241	268
Average Daily Gain (Kg/day)	1.03	0.94	1.20	0.90

APPENDIX 3A

Characteristics of *P. multocida* Isolates

ISOLATE NO	LABREF NO	ARI NO	SOURCE	PROVISIONAL ID	FINAL ID	BIO VAR	REA TYPE	RIBO TYPE	HEDD. S'TYPE	CAP. S'VAR
14	AN93/0316	PM181	Dead	*P. multocida*	*P.m. multocida*	1	1	A	3	A
18	AN93/1194	PM185	Dead	*P. multocida*	*P.m. multocida*	1	1	A	3	A
13	AN92/3378	PM180	Dead	*P. multocida*	*P.m. multocida*	1	1	A	3	A
19	AN93/1250	PM173	Dead	*P. multocida*	*P.m. multocida*	1	1	A	3	A
17	AN93/0950	PM184	Dead	*P. multocida*	*P.m. multocida*	1	3	A	3	A
15	AN92/2835	PM182	Dead	*P. multocida*	*P.m. multocida*	1	3	A	3	A
20	RN92/0858	PM174	Dead	*P. multocida*	*P.m. multocida*	1	4	B	1,15	A
22	RN92/2421	PM171	Dead	*P. multocida*	*P.m. multocida*	2	2	C	3	A
21	RN92/1126	PM172	Dead	*P. multocida*	*P.m. multocida*	2	2	C	3	A
16	AN92/3007	PM183	Dead	*P. multocida*	*P.m. multocida*	2	2	C	3	A
28	AN93/0514	PM188	Dead	*P. haemolytica*	*P.m. multocida*	2	2	C	-	A
2	AN92/3319	PM178	Sick	*P. multocida*	*P.m. multocida*	2	5	C	3	A

APPENDIX 3B

Characteristics of *P. haemolytica* Isolates

ISOLATE NO	LABREF NO	ARI NO	SOURCE	PROVISIONAL ID	FINAL ID	BIO VAR	REA TYPE	RIBO TYPE
26	AN92/4026	PM186	Dead	*P. haemolytica*	*P. haemolytica biovar 1*	H1	7	D
27	AN93/0494	PM187	Dead	*P. haemolytica*	*P. haemolytica biovar 1*	H1	6	D
29	AN93/0515	PM189	Dead	*P. haemolytica*	*P. haemolytica biovar 1*	H1	6	D
30	AN93/0582	PM190	Dead	*P. haemolytica*	*P. haemolytica biovar 1*	H1	6	D
31	AN93/0662	PM191	Dead	*P. haemolytica*	*P. haemolytica biovar 1*	H1	6	D
33	AN93/1762	PM175	Dead	*P. haemolytica*	*P. haemolytica biovar 1*	H1	8	D
34	AN93/1963	PM176	Dead	*P. haemolytica*	*P. haemolytica biovar 1*	H1	6	D
35	AN93/2025	PM177	Dead	*P. haemolytica*	*P. haemolytica biovar 1*	H1	8	D
36	RN93/0088	PM192	Dead	*P. haemolytica*	*P. haemolytica biovar 1*	H1	6	D
4	RN92/1255D	PM194	Sick	*P. haemolytica*	*P. haemolytica biovar 8*	H8	9	E
3	RN92/1255B	PM179	Sick	*P. haemolytica*	*Not P. haemolytica*	ND*	ND	ND
32	AN93/1240	PM193	Dead	*P. haemolytica*	*Not P. haemolytica*	ND	ND	ND

* ND = Not Done