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# The Significance of Pestivirus in Cattle in Australia

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# ABSTRACT

This project involved a review of possible cases of pestivirus infection that were investigated at diagnostic veterinary laboratories in all mainland states during 2001. The review included cases of reproductive disease (abortion, infertility, stillbirths, congenital defects), respiratory diseases, illthrift, wasting and mucosal disease. A number of field veterinarians were also interviewed to assess their knowledge of pestivirus infections. 1595 laboratory accessions were subjected to detailed review, 44.3% involved reproductive disease, 27.7% involved other diseases of weaners and 28.0% other diseases of older cattle. Pestivirus infection was confirmed in 253 (23.2%) cases and 90% of these were from beef cattle. There were differences in the numbers of confirmed cases and diseases observed in different states. It was concluded that pestivirus was an important cause of disease in beef cattle in Australia. There is a need for continuing education about pestivirus in the veterinary profession to improve diagnosis. There was also scope for better use of laboratory tests. When pestvirus vaccines are launched in Australia in the near future, they should be accompanied by education programs for both veterinarians and farmers, so that vaccines are used efficiently and losses caused by this virus are reduced.

# EXECUTIVE SUMMARY

Laboratory records for the calendar year 2001 were reviewed in diagnostic veterinary laboratories in all mainland states. The review encompassed the range of clinical syndromes in which pestivirus infection could be reasonably expected to be involved. These were:

- Reproductive disease including abortion, infertility, not pregnant at pregnancy diagnosis, stillbirths and perinatal deaths, congenital defects;
- Respiratory diseases (all forms);
- Wasting and illthrift;
- Mucosal disease;
- Haemorrhagic diseases/syndromes;
- Immunodeficiency syndromes including multiple infections, footrot, dermatophilosis etc.

In addition to the review of laboratory records to assess both the extent and efficiency of pestivirus diagnosis, a number of veterinarians were also interviewed by telephone to assess their knowledge of pestivirus infections.

During the laboratory review, more than 2,500 laboratory accessions were subject to a preliminary scrutiny, with 1595 being subjected to detailed review. The other accessions were excluded on the basis that pestivirus was not likely to be involved. Approximately half (44.3%) of the investigations reviewed in detail involved reproductive disease, while the proportions of cases involving other disease syndromes in older cattle or weaners were very similar (28.0% and 27.7% respectively). This review indicated that when pestivirus testing was undertaken, infection was confirmed in a total of 253 (23.2%) accessions from all cattle. There were 228 (90%) of the BVDV positive investigations from beef cattle and 25 (10%) from dairy cattle. When beef cattle were considered separately, pestivirus was confirmed in a total of 228 (25%) accessions. Although there were more accessions for the investigation of reproductive disease, the rate of confirmation of pestivirus was similar for the 3 broad disease groups (reproductive – 23%; calf/weaner – 27%; yearling/adult – 27%).

The frequency of diagnosis of pestivirus infection was highest in WA and NSW (31% and 29% of all accessions tested), intermediate in SA, Qld and Vic (24%, 22% and 20% respectively) and lowest in the NT (11%). There were some interesting differences between states, in particular:

- The low number of cases of reproductive disease that were investigated in Victoria and the Northern Territory;
- The low number of cases of enteritis and illthrift in weaners investigated in WA and the disproportionately high number of cases in Vic;
- The relatively high proportion of pestivirus cases confirmed in yearling/adult cattle in WA and conversely the low proportion in Vic and SA.

While most veterinarians were aware of pestivirus, here is still a need for continuing education in the veterinary profession to enhance understanding of the clinical manifestations of BVDV infection and approaches to diagnosis. At the laboratory level, there is some scope for improvements in the use of serological tests and their interpretation. In both the field and laboratory, there is less than optimal knowledge of the role of pestivirus infection in respiratory disease and its diagnosis. There is scope for systematic diagnostic procedures to be developed for use at both field and laboratory levels to assist with the optimal collection and testing of specimens and the interpretation of results.

The introduction of laboratory fees in some states for the testing of diagnostic specimens has reduced the quality and quantity of disease surveillance information. Fewer disease events are fully and systematically investigated because cost becomes a critical determinant for the selection of tests. Some veterinarians will not provide a description of the disease history, clinical signs or gross pathology. As a result, pathologists in laboratories are unable to review the appropriateness of tests requested, recommend alternatives, critically evaluate results and suggest alternative diseases for investigation. Consequently, data collected for "passive" disease surveillance purposes has declined in both quality and quantity. It is believed that the impact and extent of many disease syndromes, including those caused by pestiviruses, are significantly under-diagnosed.

Finally, when BVDV vaccines are launched in Australia, they should be accompanied by education programs for both veterinarians and farmers to ensure that there is appropriate use of the products.

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# 1. BACKGROUND

Bovine pestivirus, taxonomically known as bovine viral diarrhoea virus (BVDV), is ubiquitous in cattle populations around the world. In Australia, this is considered to be the most important viral infection of cattle. Some veterinarians and veterinary pathologists believe that BVDV is currently one of the most important of all pathogens of cattle in Australia.

This group of viruses is known to be a significant cause of reproductive loss, affecting breeding cattle and the conceptus from before conception through to calving. There can be reduced conception rates, early embryonic deaths, abortion, congenital defects, stillbirths and perinatal mortality. Animals that are born with persistent infections as a result of infection *in utero* during the first trimester of gestation also succumb to diseases induced by this virus, usually in the first 12-18 months of life. They can be affected with a variety of clinical entities including chronic illthrift and wasting, gastroenteritis, pneumonia and a range of secondary infections due to virus-induced immunosuppression.

Cattle exposed post-natally and undergoing a transient pestivirus infection are also often more susceptible to infection with a range of microorganisms including leptospires, chlamydia and probably neospora. In cattle managed under intensive conditions such as feedlots, BVDV has been shown to be both a primary cause of respiratory disease and to enhance the pathogenicity of other viruses and bacteria that cause respiratory disease.

In recent years, some Australian state veterinary diagnostic laboratories have implicated pestivirus in an increasing number of disease outbreaks. This is probably due to a number of factors, including the increasing awareness by recent veterinary graduates of the range of conditions in which pestivirus can be involved. The availability of rapid virus detection procedures such as the antigen ELISA and detection of nucleic acid by polymerase chain reaction (PCR) have undoubtedly contributed. However, there has been concern expressed that there may be an “over-diagnosis” of pestivirus infection when PCR is used. This is due the potential for a high incidence of false positive results if there is not rigorous attention to quality control and to the high sensitivity of the assay, with the potential to detect very low levels of residual RNA. Such levels could be found in animals that have recently undergone a transient, subclinical infection with BVDV but are currently suffering illhealth due to some other cause (eg illthrift due to parasitism). A positive PCR result could be misinterpreted and falsely incriminate pestivirus in the problem.

Awareness of this apparent increase in the diagnosis of BVDV related diseases and the imminent release of a vaccine for pestivirus in Australia has prompted Meat and Livestock Australia (MLA) to commission this project. MLA was interested in assessing the economic significance of BVDV to the Australian cattle industry. There are difficulties in assessing the impact of BVDV by conventional methods such as a cross-sectional serological (or similar) survey. These viruses tend to cycle through cattle populations in waves that are strongly influenced by herd or population (on a district basis) immunity and the mixing, introduction and other movements of animals. Further, the long delay between the time of infection and appearance of disease complicates surveillance. Timing of a survey must be precise, or extend over a long period of time, or an event that is highly significant will be missed.

During the planning phases of the project it was suggested that it would probably be impossible to arrive at a reliable estimate of the impact of pestivirus infections due to the considerable variations in recognition and diagnosis of BVDV infection by personnel associated with the cattle industry at all levels, extending from farmers through to veterinary clinicians, veterinary pathologists and virologists. However, it was thought that examination of historical data that is available on a national basis from diagnostic laboratories and field veterinarians would provide some insight into the scope of pestivirus-induced disease and perhaps identify areas in which there were deficiencies in diagnostic approaches employed in different regions.

# 2. AIMS

The broad aim of this project was to assess the extent to which pestivirus is involved in the occurrence of disease in cattle in Australia, with an emphasis on the beef cattle sector. The project design also sought to assess the extent to which BVDV infections are likely to be underestimated because of:

1. Failure of field veterinarians to recognise the range of syndromes in which BVDV can be involved and/or to seek laboratory confirmation;

2. Failure of field veterinarians to request appropriate testing when submitting specimens;

3. Failure of veterinary pathologists to appropriately consider BVDV infection and request relevant testing;

4. Inappropriate collection of specimens for testing.

The syndrome could also be significantly under-diagnosed because of a failure of the grazier to seek investigation of a problem but this could not be included in this project.

# 3. PROJECT DESIGN AND METHODS

The project involved 2 main lines of investigation. These were:

- A review of diagnostic investigations (cattle only) undertaken by selected veterinary diagnostic laboratories in all states during the calendar year 2001 and

- Personal telephone interviews of a representative number of veterinarians involved in any type of cattle practice.

## 3.1. Review of Diagnostic Investigations in Veterinary Laboratories

The purpose of this phase of the project was to review the data that is available on a national basis in record systems held by veterinary laboratories. Because of the likelihood of seasonal variations in the manifestations of disease due to pestivirus, it was decided to review laboratory records covering a 12-month period. Submissions to laboratories at any time during the calendar year 2001 were identified for review.

All major mainland State government diagnostic veterinary laboratories and at least one private veterinary pathology laboratory were invited to participate in this project. In particular, Government laboratories in New South Wales (Camden), Northern Territory (Darwin), Queensland (Brisbane), Victoria (Melbourne) and Western Australia (Perth) were approached because each of these states offers diagnostic virology services. The private veterinary pathology laboratory in South Australia was also included to ensure the collection of data from that state. Where there were state regional laboratories, the survey was broadened to assess the number of investigations where specimens were not referred to a central specialist laboratory for virology testing. Tasmania was not included in the investigation because of the relatively small beef cattle population and the fact that specimens are referred to other states for virology investigations.

In December 2001, Dr P. Rolfe (Project Manager, Animal Health, MLA) wrote to the Chief Veterinary Officers of the selected states, seeking their co-operation and to permit visits to their laboratories. Subsequently, participating laboratories were asked for statistics for the calendar year 2001 for:

- The total number of laboratory accessions (all species, all reasons) received during the study period;

- The total number of laboratory accessions for disease diagnosis;

- The total number of diagnostic submissions involving cattle, with the proportion involving beef cattle.

In addition, the laboratory managers were asked for a list of all accessions from cattle that were presented involving investigations of:

- Reproductive disease including abortion, infertility, not pregnant at pregnancy diagnosis, stillbirths and perinatal deaths, congenital defects;

- Respiratory diseases (all forms);

- Wasting and illthrift;

- Mucosal disease;

- Haemorrhagic diseases/syndromes;

- Immunodeficiency syndromes including multiple infections, footrot, dermatophilosis etc.

Lists of all accessions in which pestivirus testing had been undertaken were also requested.

Once the above statistical information was available, arrangements were made for a veterinary pathologist with extensive pestivirus expertise to visit the laboratory. At this visit, all laboratory records (specimen advice and final reports) for 2001 for cattle submissions involving the above syndromes were reviewed. All submissions were categorised according to the criteria described under 'Aims' (points 1-4) above. Relevant data from each accession was also examined to provide a dissection of the relative occurrence of different clinical syndromes where pestivirus could have been involved or had been confirmed. This included, where available, estimates of number of animals affected, direct losses attributable to those syndromes where records permitted and the management system on the property. These data were entered into a database to produce estimates of the confirmed prevalence of pestivirus-induced disease, the potential extent of the problem and to identify areas at both field and laboratory levels that require improvement so that pestivirus syndromes are accurately diagnosed. These assessments were made by Dr P. Kirkland (WA, NSW, Vic, Qld – Yeerongpilly, Rockhampton, Townsville and Toowoomba - part) or Dr K. Walker (SA, NT, Toowoomba – part). "Eligible" accessions were those that met the clinical criteria described above and where the accession was for the investigation of a primary disease outbreak. Specifically, follow-up sampling was excluded when an initial diagnosis had been made on that property. The broad geographical location of the properties for investigations in the eastern states was subsequently re-coded into regions to correspond to the regions that CSL had used in their practitioner survey.

## 3.2. Interviews of Cattle Veterinarians

A survey of veterinarians engaged in cattle practice was conducted and involved the delivery of a standardised questionnaire. It addressed similar issues to the laboratory investigations but was conducted by telephone interview. In order to randomly select participants who were engaged in cattle practice, the plan was to obtain a proportion of members of the Australian Association of Cattle Veterinarians (AACV) by selection of random numbers from the membership list. However, privacy regulations prevented access to the membership list. Consequently, a proportion of members was contacted by the AACV secretariat to gain approval for their participation in a survey on animal health for MLA (details not specified). Of more than 350 contacted, there were 52 respondents.

Each practitioner selected for interview received no prior warning of the nature of the interview, to ensure that responses reflect "current" working knowledge, and did not take place after there had been any opportunity for a review of publications or other literature. Of the selected veterinarians who responded, 35 were interviewed by Dr P. Kirkland and Ms D. Finlaison.

Interestingly, CSL Veterinary Division, aware of this project, also undertook a survey of AACV members to assess knowledge of pestivirus and interest in pestivirus vaccines. The survey consisted of a written questionnaire, which contained a series of questions that were almost identical to those used in the project telephone interviews. There was a significantly higher response to this survey (due to a worthwhile incentive offered by the company). Approval has been given to include extracts of some of the results in this report, due to the complimentary nature of the data.

# 4. RESULTS

## 4.1. Review of Diagnostic Investigations in Veterinary Laboratories

### *4.1.1. Laboratory Accession Statistics for 2001.*

The statistics provided by the managers of the participating laboratories are summarised in Table 1. To allow a more valid comparison of the number of diagnostic accessions from cattle, the numbers of beef and dairy cattle for 2001 are shown in Table 2. In NSW, charging for all diagnostic accessions on the basis of full-cost recovery was implemented on 1 November 1999. There was a belief that the number of accessions for diagnostic virology had declined significantly and that this may have a bearing on the number of pestivirus diagnoses in NSW. To gain an objective assessment of this change, the number of diagnostic accessions to NSW laboratories was determined for the 5-year period 1997-2001 (see Table 3). This gave a period of 2 years prior to the change and the subsequent 2 years. The numbers of accessions for pestivirus investigation in the Virology Laboratory in the corresponding time period are also listed. The data shows a decline of almost 60% in the total number of accessions and a decline of about 24% in the proportion of pestivirus investigations relative to the total number of diagnostic accessions from cattle. These data will be examined further (see section 1.2 below)

**Table 1. Accessions to Diagnostic Veterinary Laboratories, 2001.**

| State | Total Accessions | Diagnostic Accessions | Diagnostic Accessions – Bovine | Diagnostic Accessions – Beef | Accessions – potential BVDV involvement |
|---|---|---|---|---|---|
| **NSW** | 23,142 | 6,401 | 2,641 | 1,886 | 584 (22%***) |
| **NT** | 1,883 | 498 | 323 | 310 | 32 (10%) |
| **QLD** | 18,341 | 5,780 | 3,019 | 1,970 | 533 (18%) |
| **SA** | 6,000 * | 5,000 * | 1,825 | 1,575 | 53 (3%) |
| **VIC** | 5,827 | 2,232 | 640** | UK | 184 (29%) |
| **WA** | 6,036 | 1,728 | 548 | UK | 210 (38%) |
| **Total** | 61,229 | 21,639 | 8,996 | >5,741 | 1,595 (18%) |

* Approximate Nos only;

**Includes 180 accessions with no history

*** Proportion of bovine accessions

**Table 2. Diagnostic Accessions for Cattle in 2001 Relative to Livestock Numbers.**

| State | Total Cattle (000's)* | Diagnostic Accessions – Bovine | Total Beef Cattle | Diagnostic Accessions – Beef | Bovine Accessions – potential BVDV involvement |
|---|---|---|---|---|---|
| **NSW** | 6470 | 2641 | 6012 | 1886 | 584 (9.02)** |
| **NT** | 1722 | 323 | 1722 | 310 | 32 (1.85) |
| **QLD** | 11586 | 3019 | 11289 | 1970 | 533 (4.63) |
| **SA** | 1343 | 1,825 | 1136 | 1,575 | 53 (3.95) |
| **VIC** | 4739 | 640 | 2663 | UK | 184 (3.88) |
| **WA** | 2210 | 548 | 2082 | UK | 210 (9.50) |
| **Total** | 28070 | 8,996 | 25372 | >5,741 | 1595 (5.68) |

* Source: ABS: Principal Agricultural Commodities, Preliminary statistics, 2001.

** Number of diagnostic accessions and (bracketed) rate per 1,000 cattle (beef and dairy)

**Table 3. Accessions to NSW Veterinary Laboratories, 1997- 2001.**

| Year | Total Accessions | Diagnostic Accessions | Diagnostic Accessions – Bovine | Diagnostic Accessions – Beef | Virology Accessions – BVDV testing |
|---|---|---|---|---|---|
| **1997** | 25,637 | 11,035 | 5,174 | 3,196 (62%*) | 1,415 (27%*) |
| **1998** | 25,675 | 10,507 | 4,550 | 2,391 (53%) | 1,209 (26.5%) |
| **1999** | 26,995 | 18,646 | 4,360 | 2,348 (54%) | 1,116 (25.6%) |
| **2000** | 22,640 | 7,484 | 3,423 | 2,117 (62%) | 767 (22.4%) |
| **2001** | 23,142 | 6,401 | 2,641 | 1,886 (66%) | 590 (20.6%) |

* Proportion of all bovine accessions;

### *4.1.2 Review of Individual Laboratory Accessions*

Individual laboratory accessions were reviewed for the following laboratories:

**New South Wales**

NSW Agriculture – Regional Veterinary Laboratories Menangle, Orange and Wollongbar;

**Northern Territory**

Dept of Primary Industries & Fisheries, Berrimah, Darwin NT;

**Queensland**

Animal Research Institute, Yeerongpilly, Brisbane

Regional Veterinary Laboratory, Rockhampton;

Regional Veterinary Laboratory, Toowoomba;

Regional Veterinary Laboratory, Townsville;

**South Australia**

Idexx Laboratories, Adelaide;

**Victoria**

Victorian Institute of Animal Sciences, Attwood;

**Western Australia**

Agriculture WA, Veterinary Laboratory Albany and South Perth.

After the "desk audit" had been completed on accessions that involved syndromes in which pestivirus could reasonably be involved, the review of individual accessions took place. There was a total of 1595 accessions that were subjected to review. The dissection of these into broad classifications was as follows:

| | Diary | Beef | Total |
|---|---|---|---|
| **Reproductive disease** | **198** | **618** | **816 accessions** |
| **Diseases of calves & weaners** | **61** | **329*** | **390 accessions** |
| **Diseases of yearlings and adult cattle** | **54** | **335**** | **389 accessions** |
| **Totals** | **313** | **1282** | **1595 accessions** |

* Includes 8 accessions from feedlots

** Includes 25 accessions from feedlots

The above classifications of livestock by age will not be precise, but give a general appreciation of the ages of animals involved. For example, there are probably modest variations in the overlap between older animals in the "weaner" and younger animals in the "yearling" groups. There were some areas where there were obvious differences in the frequency of investigation of different syndromes between the states. However, these will be described later in more detail.

When this very broad grouping of cases is considered, pestivirus was reliably identified in 258 (16.2%) of accessions. However, this is somewhat misleading because there were 504 cases in which pestivirus testing was not even conducted. A high proportion of these (270) were cases of reproductive disease where samples were submitted for testing only for Campylobacter infection or leptospirosis. Further discussion of reproductive disease will follow (see section 1.5). For the subsequent analysis of the data, these accessions were excluded and the analysis limited to accessions where pestivirus testing was completed.

The results of the detailed review of individual accessions in each state laboratory for which pestivirus testing was performed are summarised by clinical syndrome and by State in Table 4 (see Appendix). The broad summary of these accessions is as follows:

| | Diary | Beef | Total |
|---|---|---|---|
| **Reproductive disease** | **113** | **378** | **490 accessions** |
| **Diseases of calves & weaners** | **44** | **263** | **307 accessions** |
| **Diseases of yearlings and adult cattle** | **33** | **261** | **294 accessions** |
| **Totals** | **190** | **901*** | **1091 accessions** |

***** Includes 8 accessions from feedlots

Approximately half (44.3%) of the investigations reviewed in detail involved reproductive disease, while the proportions of cases involving other disease syndromes in older cattle or weaners were very similar (28.0% and 27.7% respectively).

Pestivirus was confirmed in a total of 253 (23.2%) accessions from all cattle. There were 228 (90%) of the BVDV positive investigations from beef cattle and 25 (10%) from dairy cattle. The proportion of cases from beef cattle that were shown to involve pestivirus was slightly disproportionate to the number of accessions from beef cattle (83%) compared to dairy cattle (17%). However, it should be noted that in Victoria, the breed of cattle was not always apparent. When such accessions were encountered, the breed was assigned on the basis of the district of origin, and in cases of uncertainty, the cattle were classified as "beef". However, it is unlikely that this would have a major influence on the overall results due to the small proportion of accessions involved.

The data for beef cattle are shown in Table 5 (See Appendix). When beef cattle were considered separately, pestivirus was confirmed in a total of 228 (25.3%) accessions. Although there were more accessions for the investigation of reproductive disease, the rate of confirmation of pestivirus was similar for the 3 broad disease groups (reproductive – 23.1%; calf/weaner – 26.5%; yearling/adult – 27.2%). The frequency of diagnosis of pestivirus infection was highest in WA and NSW (30.9% and 29.2% of all accessions tested), intermediate in SA, Qld and Vic (23.7%, 21.9% and 21.3% respectively) and lowest in the NT (11.1%). The complete dissection of clinical syndromes with rates of pestivirus diagnosis by state are shown in Table 5. In many cases, the number of accessions within a syndrome are too small to allow reliable comparisons. There are however, some interesting differences between states that warrant comment. In particular, these are:

- The low number of cases of reproductive disease that were investigated in Victoria and the Northern Territory;

- The low number of cases of enteritis and illthrift in weaners investigated in WA and the disproportionately high number of cases in Vic;

- The relatively high proportion of pestivirus cases confirmed in yearling/adult cattle in WA and conversely the low proportion in Vic and SA.

It is possible that some of these differences may reflect differences in livestock management in the more extensive states (Qld & WA) compared to the south. While there was more than 2.5 times more submissions to laboratories in Queensland compared to Victoria, the numbers submitted from animals classified as "calves and weaners" was almost the same and the proportion of pestivirus cases was similar. There were markedly more cases of "enteritis" in Victoria compared to other types of cases in weaners, but this may be 'skewed' by the laboratory classification of cases where there was a scant history. When the classifications of enteritis and illthrift are combined, there is a similar number of accessions in NSW, Qld and Vic. The "calves and weaners" submissions in Victoria comprised 64% of all accessions – more than twice as many as any other state.

In order to investigate these differences further, the submission data and numbers of confirmed pestivirus cases were expressed as rates per 1,000 head of beef cattle in the respective states (See Appendix, Table 6). This was done in an effort to provide a degree of standardisation of the data relative to the cattle populations in each state. While this does provides a better measure of relativity, It is clearly recognised that even this transformation is inaccurate because the submissions reviewed represent investigations at a property or holding level. The most accurate transformation would be relative to the number of properties in each state but this statistic was not readily available.

Most of the trends described previously are still apparent in the transformed data. The total number of cases investigated in the defined syndromes was comparable in NSW and WA. The proportion of investigations in these states was almost double the number in any of the other states. The proportion of investigations were similar in Vic, SA and Qld in declining order) and lowest in the NT. When the rate of confirmation of BVDV infections is compared, interestingly, the ranking for total numbers of pestivirus cases confirmed were the same. These adjusted rates did rank the 3 individual intermediate states slightly differently compared to the absolute numbers of cases of pestivirus infection confirmed. That is, there was a higher rate of pestivirus confirmation in Vic than SA and Qld respectively when adjusted for beef cattle numbers. The other obvious differences, as observed previously, were the high rate of investigation and confirmation of disease in weaners in Victoria, the low rate on weaners in WA and the low rate of investigation of reproductive disease and disease in adult cattle in Victoria.

The data sets generated during this project have many deficiencies but nevertheless many of the trends confirm the judgement of the project team members in respect to the significance of pestivirus as a pathogen of cattle. There is little doubt, however, that the significance of this virus, in terms of absolute numbers of cases that occur, is still grossly underestimated. The situation in NSW is a good example in that both the number of diagnostic accessions and also the proportion of diagnostic cases referred for virology have declined markedly over the last 5 years. However, it is not expected hat the rate of pestivirus confirmation has changed much over this period. One can only speculate on relative rates of under-diagnosis in other states. While differences in herd and livestock management do have a potential impact on the incidence of pestivirus infection, it is highly improbable that the major differences in rate of disease in different classes of livestock indicate true differences in the impact of pestivirus infection. Rather, differences in diagnostic capabilities at a both field and laboratory levels are a more likely explanation.

When the differential diagnoses were reviewed, pestivirus was included or alternatively, not considered, in the differential diagnosis of the defined syndromes with almost equal frequency (included in 52.4% of cases). Interestingly, when the clinician included pestivirus in the differential diagnosis, it was more likely that a confirmation of pestivirus infection would be made (28.8% of cases

compared to 17.4%). It is interesting to speculate whether this is a true reflection of diagnostic acuity, but it is unlikely that this is so.

### *4.1.3 Incidence of Pestivirus Infections*

It was not possible determine the numbers of confirmed disease events due to pestivirus, Australia-wide, with any greater precision than at the accession level. When the data were analysed, an accession was assessed as "positive" regardless of the number of animals that gave a positive test result.

There was considerable variation in the provision of statistical information by field veterinarians in different states on the numbers of animals affected and the numbers 'at risk'. In at least one state this information was provided for a high proportion of accessions while in another, the information was rarely provided. However, the data were analysed for those accessions where the relevant statistics were provided. Perhaps surprisingly, statistical information was provided for 650 (59.1%) accessions. The relevant numbers of animals involved are summarised in Table 7.

It is highly probable that these statistics are gross underestimates of the numbers of animals affected and 'at risk' because there were many accession where statistics were only provided for a group of animals in which the problem was current. This could be quite misleading because of potential for spread to other groups on the farm, or for the presence of as yet unrecognised infection in other groups. Nevertheless, there are probably some trends that are relevant. Specifically, while there are nominally similar proportions of beef and dairy cattle at risk on affected farms, the rate of pestivirus induced disease appears to be much higher on beef farms than on dairies. This would be consistent with the author's experience during many years of diagnostic investigations. Pestivirus also appears to be more frequently a cause of death on beef farms than on dairy properties. This bias could well be real, not due to a difference in the behaviour of the virus but because of the removal of at least half of the young animals (male calves) from dairies at an early age. Such animals certainly are involved in many of the deaths due to BVDV infection in beef herds. Similarly, culling of illthrifty or poorly grown heifers is more likely to occur at an early age on a dairy farm. Further, these young animals are also a potent source of virus to infect other breeding animals in the herd, so their impact is likely to be greater in a beef herd where they may be retained until an older age. The observation that pestivirus infection emerges as a significant cause of death in feedlot cattle is not surprising, although the rate is artificially high because many other causes of death probably are not investigated at a laboratory.

Table 7 – Numbers of cattle at risk on farms where pestivirus infection was diagnosed.

| Enterprise | Classification | All farms investigated | BVDV Pos farms (%) |
|---|---|---|---|
| **BEEF** | Cattle 'at risk' | 140 178 | 20997 (14.9%) |
| (509 farms) | No. Affected | 6839 | 1152 (16.8%) |
| | No. Dead | 401 | 111 (27.7%) |
| **DAIRY** | Cattle 'at risk' | 19434 | 3252 (16.7%) |
| (128 farms) | No. Affected | 788 | 72 (9.1%) |
| | No. Dead | 94 | 8 (8.5%) |
| **FEEDLOT** | Cattle 'at risk' | 51936 | 44550 (85.8%) |
| (13 farms) | No. Affected | 152 | 34 (22.4%) |
| | No. Dead | 17 | 10 (58.8%) |
| **ALL FARMS** | Cattle 'at risk' | 211548 | 68799 (32.5%) |
| (650 farms) | No. Affected | 7955 | 1289 (16.2%) |
| | No. Dead | 547 | 131 (23.9%) |

## *4.1.4 Sample Collection and Testing Procedures*

Of the 504 accessions that were excluded from the specific analysis for pestivirus, there were 79 where pestivirus had actually been requested but the specimens submitted were either unsuitable or inappropriate for examination. The remaining 435 were largely accessions where testing for a single agent (often Campylobacter) was requested. Further comments on the diagnosis of reproductive disorders are made below.

Two hundred and fifty eight of the 504 accessions that were not tested for pestivirus were not examined because the specimens submitted to the laboratory were either not appropriate or unsuitable. In 26 of these accessions, the clinician had examined suitable material but did not send it to the laboratory. Of the 504 accessions excluded, there were 246 where the tests conducted for pestivirus were not considered appropriate in the context of achieving a diagnosis. For example, there were a number of calves with cerebellar hypoplasia (either at term or aborted foetuses) in which either virus isolation or PCR was conducted. Such cases are almost uniformly confirmed by the detection of BVDV specific antibody in foetal fluids or pre-colostral serum because the pathological changes are the outcome of foetal infection at an age when the foetus is immunocompetent. Respiratory disease investigation is another area that was often poorly investigated. In a number of instances, serology was conducted, but only on either acute or convalescent sera, rather than paired acute and convalescent sera. When tissues were submitted, material was frequently tested by antigen ELISA but virus isolation for BVDV was rarely done. In some instances, virus isolation for IBR virus was conducted on cell cultures. Usually the same cell cultures are used for pestivirus infection as for IBR – to test for BVDV, it is only necessary to include an immunoperoxidase staining procedure to detect BVDV virus in these cultures. Many cases of respiratory disease are due to acute transient infections, rather than persistent infections so virus isolation (or PCR) is the only test that is appropriate on tissues. Nasal and ocular swabs are also a reliable specimen for the investigation of respiratory disease and also allow testing for other respiratory viruses to be conducted. These were rarely submitted. In fact, a number of pathologists and many field veterinarians were not aware of the suitability of swabs submitted in viral transport medium.

The application of different diagnostic tests for the confirmed pestivirus cases is shown in Table 8.

**Table 8. Diagnostic tests used for the confirmation of pestivirus infections.**

| Test | NSW | NT | Qld | SA | Vic | WA | Total |
|---|---|---|---|---|---|---|---|
| **Ag ELISA** | 58 | 0 | 15 | 2 | 24 | 22 | 121 |
| **PCR** | - | - | 27 | - | - | - | 27 |
| **Serology** | 40 | 2 | 32 | 8 | 2 | 21 | 105 |
| **Total** | 98 | 2 | 74 | 10 | 26 | 43 | 253 |

Another major area for comment in regard to improved use of diagnostic tests relates to serology. In many cases, the serology that was applied cannot be interpreted. For example, when the AGID test is used, the different degrees of reactivity are sometimes not reported. It is important that the AGID reaction strength is reported, because there is a direct correlation between high positive AGID results and recent infection in the animals concerned. While this does not provide a definitive diagnosis, it does guide the clinician to further consider pestivirus, or to exclude it from the differential diagnosis. In regard to the VN test, less emphasis can be placed on high titres because titres can continue to rise, and remain high for a long time (perhaps 9-12 months) after infection occurred. This makes it impossible to develop an association between recent exposure to infection and reproductive loss

during the last pregnancy. The other notable feature of these test results is the few cases confirmed by serology in Victoria. This is largely a reflection of the small number of cases of reproductive disease submitted for investigation.

### *4.1.5 Reproductive Disease and Other Infectious Agents*

In the entire data set (including all accessions where there was no testing for pestivirus), there were 816 accessions for the investigation of reproductive problems. The dissection of the most common diagnoses for these were:

| | |
|---|---|
| Pestivirus | 105 cases (12.9% of total) |
| Leptospirosis | 61 cases (including L. hardjo and L. pomona) (7.5% of total) |
| Campylobacter | 48 cases (5.9% of total) |

In addition to the above most frequent diagnoses, there were occasional cases of Akabane virus infection, Neospora infection, Salmonella infection and infection with several other bacterial agents. When all diagnoses are considered, there was an infectious aetiological agent associated with approximately 30% of all cases of reproductive disease investigated (including a significant proportion of cases for which there was not a full range of specimens submitted).

### *4.1.6 Laboratory Records - Ease of Retrieval and Quality of Data*

Most states were able to retrieve from their laboratory databases a list of accessions that were relevant to the syndromes under investigation. Generally it was also possible to obtain a very brief summary of the presenting signs and the diagnosis. When such information was available, it facilitated scrutiny of the data to develop a refined accession list for individual examination during the laboratory visit. In two instances, this was not possible and it was necessary for professional staff familiar with the laboratory records system to undertake a preliminary cull. This was achieved by excluding large blocks of records where there were key parameters in the history/disease suspected that suggested the cases were not of interest to the study (eg TSE surveillance cases). Further detail could only be obtained by examination of individual records. Fortunately, the states with the largest data sets were able to provide good listings and accurate summaries so that unnecessary individual record examination could be minimised. Generally, the same comments and limitations also applied to the ability of a laboratory/state to provide the general statistical information sought. Those states that were able to provide detailed accession summaries were also able to readily provide statistics that would identify the number of true diagnostic cases (compared to health certification/export testing) by animal species and, in most cases, generally a separation of beef and dairy cattle.

While most states could provide general statistical information in some form, the quality of information provided with individual accessions was very variable. It would appear that the introduction of laboratory fees in some states for the testing of diagnostic specimens has reduced the quality of disease surveillance information. It would appear that fewer disease events are fully and systematically investigated because cost becomes a critical determinant for the selection of tests. Some veterinarians will not provide a description of the disease history, clinical signs or gross pathology. As a result, pathologists in laboratories are unable to review the appropriateness of tests requested, recommend alternatives, critically evaluate results and suggest alternative diseases for investigation. Consequently, data collected for "passive" disease surveillance purposes has probably declined in both quality and quantity. It is believed that the impact and extent of many disease syndromes, including those caused by pestiviruses, are significantly under-diagnosed.

In the 2 states where there was consistently superior information provided with specimens, some of the data was confusing and potentially misleading. The format of specimen advice forms naturally dictates the type of information provided by field veterinarians (and is designed to do so). Some forms are clearly designed to gather detailed data for epidemiological analysis, but may sometimes restrict the extent of data provided by "leading" the field veterinarian too much. The most obvious example is the provision of statistical data on numbers of animals involved in a disease event. Many veterinarians provided quality data about an individual mob of cattle in which a problem was currently being investigated (in response to a prompt for "numbers at risk") but failed to complete "the big picture". It many cases it was obvious that the enterprise was large, but there was no other data about total numbers of livestock on the property. While this criticism could be levelled at a significant proportion of accessions, veterinarians submitting specimens to these laboratories generally provided good descriptions of clinical and pathology observations.

Finally, one of the major deficiencies appeared in the interaction between private pathology laboratories and their use of government laboratories for specialised tests (eg testing for pestivirus). When specimens were referred from a private laboratory to a government laboratory for further examination, a consistent trend was identified in all states. There was a request for very specific tests to be carried out, but rarely any description of the presenting problem, the clinical signs or gross pathology. In these cases, pathologists in government laboratories are clearly operating in a 'vacuum' and can render little assistance to the client by way of suggestions for alternative tests or in some cases, interpretation of results.

## 4.2. Interviews of Veterinarians

### *4.2.1 Telephone Interviews of Cattle Veterinarians*

Overall, the results of this survey (and the CSL survey) are not unexpected. There was generally good agreement between the 2 surveys.

Of the 35 pracititioners interviewed by telephone, 30 were in private practice, 4 were government field officers and 1 was employed in industry (in a research capacity). The state of origin of these veterinarians was as follows:

| | | | |
|---|---|---|---|
| NSW | 17 | Qld | 4 |
| SA | 2 | Tas | 1 |
| Vic | 8 | WA | 3 |

Of the 30 private practitioners, 1 was in a beef/sheep practice, 3 were in dairy practice and the other 26 were in mixed small animal/cattle practice (mostly beef practice). Although the numbers were limited, the regions in which these veterinarians were located appeared to provide a reasonably good distribution across the cattle raising areas of Australia.

The participating veterinarians were grouped into approximate ages and year of graduation as follows:

| | |
|---|---|
| Before 1976 (>50yrs old) | 12 |
| 1976-1985 (40-49 yrs) | 7 |
| 1986-1995 (30-39 yrs) | 12 |
| After 1995 (<30 yrs old) | 4 |

The veterinary schools from which these veterinarians graduated were:

| | |
|---|---|
| Melbourne | 5 |
| Murdoch | 5 |
| Queensland | 12 |
| Sydney | 13 |

The responses to the individual questions are summarised below. A copy of the full questionnaire is provided in Appendix 1.

**(i) Question 1: Do you recognise pestivirus by any other name?**

Twenty six veterinarians also recognised pestivirus by the terms BVDV and mucosal disease virus while 2 recognised it as BVDV only. There were 7 vets who were not aware of any other names.

**(ii) Question 2: What clinical syndromes can this virus cause (world-wide)?**

The number of positive responses are listed beside the specified options as follows:

| | |
|---|---|
| a) Reproductive disease | **33/35** |
| b) Respiratory disease | **25/35** |
| c) Immunosuppression | **32/35** |
| d) Enteritis | **29/35** |
| e) Haemorrhagic disease | **10/35** |
| f) Mucosal disease | **33/35** |
| g) Illthrift | **34/35** |

**Comments:** There appeared to be no relationship between the lack of knowledge of pestivirus as a cause of haemorrhagic disease and time since graduation. The negative response was uniformly distributed across all groups with about 3/4 of each age group not knowing that some strains of BVDV (all exotic to Australia) cause a severe haemorrhagic disease syndrome.

**(iii) Question 3: Do you think pestivirus in Australia is a significant cause of:**

The number of positive responses are listed beside the specified options as follows:

| | |
|---|---|
| a) Early reproductive loss (conception failure)? | **27/35** |
| b) Abortion? | **28/35** |
| c) Congenital defects? | **20/35** |
| d) Stillbirths? | **26/35** |
| e) Calf pneumonia? | **16/35** |
| f) Weaner illthrift | **28/35** |
| g) Respiratory disease in feedlot cattle | **26/35** |
| h) Haemorrhagic enteritis | **23/35** |

**Comments:** The main feature of the above replies is the relatively low appreciation of pestivirus as a cause of respiratory disease in either calves or feedlot cattle. When the age profile of the veterinarians was examined, although the number in each group was small, there was a clear tendency for the group graduating between 1976-85 to be over-represented (6/7 compared to not more than 50% of the other groups).

When exploring the appreciation of pestivirus as a cause of congenital defects, even though a majority of vets knew that BVDV could cause congenital defects, few (only 5 of the 20 respondents) could nominate any pathological entities. This could also perhaps indicate a misunderstanding of the question, in that many of the outcomes of BVDV infection (eg persistent infection) are the product of *in utero* infection. Of the specific congenital defects described, 4/5 respondents nominated

arthrogryposis (2 in conjunction with neurological disorders). The other, consistent with misunderstanding this question, nominated "weak calves". None of the interviewees described cerebellar hypoplasia (the most common defect) or optic defects (less common). These responses also probably indicate a lack of appreciation of the onset of the immune response in cattle and the relationship between infection at different stages of foetal development and the different pathological entities that result.

**(iv) Question 4: Are your clients aware of this virus?**

There were 23 positive responses to this question, that is, practitioners thought that about 65% of their clients knew of pestivirus.

**(v) Question 5: What species of livestock can be infected?**

Less than half (16/35) of vets were aware that pestivirus could infect other species (potentially important from an epidemiological and disease control perspective). Of the positive respondents, 5 nominated sheep only, 2 sheep and other small ruminants, 2 pigs only, 1 pigs and sheep and 3 were not able to nominate the other livestock.

**(vi) Question 6: How frequently do you diagnose pestivirus infections in cattle?**

**T**he responses to this question were as follows:

| | Never | Rarely | Occasionally | Often |
|---|---|---|---|---|
| Suspect/Diagnose: | | 9 | 22 | 4 |

These responses would suggest that pestivirus is not over-diagnosed as a result of practitioner "enthusiasm" for BVDV as a major cause of disease in cattle.

**(vii) Question 7: How frequently do you seek laboratory confirmation of pestivirus infections in cattle?**

The responses to this were:

| | Never | Rarely | Occasionally | Often |
|---|---|---|---|---|
| Seek Laboratory Confirmation: | | 6 | 9 | 20 |

It could be argued that an accurate diagnosis of pestivirus infection cannot be made on clinical grounds alone. A majority of practitioners do seek laboratory support to make a diagnosis but, interestingly, there are quite a few who seem to make a diagnosis on clinical grounds alone. Such cases, if diagnosed accurately, would not have been captured in the laboratory audit undertaken during this project.

**(viii) Question 8: To what extent to laboratory charging policies influence your submission of specimens for pestivirus diagnosis?**

More than half (21/35) of the interviewees indicated that charging moderately (13 vets) or heavily (8 vets) influenced their decision to seek laboratory support for a diagnosis. When these responses were dissected, there was a lower proportion of respondees from Qld (1/4) and WA (1/3) compared to NSW (10/17), SA (2/2), Vic (7/8).

**(ix) Question 9: Collection of specimens for pestivirus diagnosis.**

Due to the diversity of responses, it is not practical to provide a detailed list of responses. The main trends to emerge from questions related to the selection of specimens was that there appears to be a lack of awareness of the value of whole, unclotted blood (EDTA or heparin treated) and fresh tissues (lung, spleen, lymph nodes) for pestivirus detection (especially by antigen ELISA). There was a clear tendency to submit clotted blood, regardless of the syndrome or age of animal. The other deficiency was a lack of appreciation of the investigation of respiratory disease, especially the collection of nasal swabs for virus isolation and paired sera for serology.

**(x) Question 10: Control measures currently recommended**

Only 19/35 veterinarians were able to describe practical measures for the control of pestivirus in the absence of a vaccine. The 2 options described were mixing of mobs of cattle (especially heifers) prior to joining (16 responses) and the isolation of introduced animals (3 responses).

**(xi) Question 11 & 12: Use of vaccines when available**

A majority of veterinarians (24/35) indicated that they would recommend the use of a vaccine it there was one available. However, few (5/35) could comment (Q12) on how an inactivated vaccine could be best used in a breeding herd.

**General Comments**

The answers to the above questions are consistent with the trends observed during the audit of laboratory records. In particular, practises for the investigation of respiratory disease are very similar to what was encountered at the laboratory level, especially strategies to confirm infection in live animals (eg no collection of nasal swabs). There is also a tendency to collect clotted blood regardless of the clinical syndrome.

## *4.2.2. Interviews of Veterinary Pathologists*

As would be expected, most of the veterinary pathologists had a better than average understanding of pestivirus infections in cattle. Surprisingly, however, there was generally a poor understanding of the role of BVD virus in respiratory disease and the samples/methods that are appropriate for diagnosis. There was also less than optimal understanding of the diagnosis of pestivirus induced congenital defects. Although pestivirus diagnosis was frequently attempted for cases of arthrogryposis, neurological disorders and other defects, there was a consistent tendency to attempt only the detection of antigen. This was especially so for the investigation of cerebellar disease. Precolostral sera or body fluids from such cases are almost always seropositive because in-utero pestivirus infection has occurred after the development of immune competence. There were a number of cases noted during the laboratory review that were probably due to BVDV infection but were not confirmed because only antigen or virus detection was attempted.

## *4.2.3. CSL Veterinarian Survey*

The general trends observed in the CSL survey are consistent with the data obtained during this study. Overall, 59% of veterinarians indicated that pestivirus was important to their clients. A much higher proportion of all practitioners in NSW (69%), southern and central Queensland (69%) and Western Australia (63%) than in other areas indicated that they believed that pestivirus was important to their clients. These are also the states where there was a higher rate of diagnosis. This is probably

not a reflection of a higher incidence in those areas, but rather a greater understanding by practitioners and a greater likelihood that they would seek a diagnosis. In Victoria, the rate was lower than average (49%). When dairy specialists were selected, the trends were similar (in terms of geographical areas) but the overall rate of positive responses was slightly lower (54% thought that BVDV infection was important to their clients). Interestingly, in NSW, the rate of positive responses (67%) was slightly higher than in the general veterinary community but the rate was much lower (44%) in Victoria. There was a much higher positive response rate from feedlot practitioners (76% thought that pestivirus was important to their clients). In terms of the presenting syndrome, 90-95% of veterinarians recognised BVDV infection as an important cause of reproductive disease or the mucosal disease complex but only 48% as a respiratory pathogen. An interesting statistic of relevance to the laboratory review was the proportion of pestivirus cases for which practitioners sought confirmation. There was a strong correlation between those who thought that pestivirus was significant and the rate of laboratory use and confirmation of BVDV infection. However, none of the practitioner groups indicated that they sought laboratory confirmation for more than 50% of the cases that they saw. In the higher usage groups, laboratory confirmation was the basis for diagnosis of 40-50% of cases (NSW, Qld, WA) whereas in Victoria the rate was 30%.

In regard to use of vaccine, 76% of veterinarians indicated that they would recommend the use of a vaccine.

# 3. CONCLUSIONS AND RECOMMENDATIONS

The statistics generated during this project only represent a crude estimation of the prevalence of disease due to pestivirus at a herd (accession) level. Due to difficulties with interpreting serology data available in some laboratories, it is possible that the rate of confirmation by serology of pestivirus induced reproductive disease could be an overestimate within that sub-category. Conversely, practitioners responding to the CSL survey indicated that they often did not seek laboratory confirmation. However, the diagnosis of pestivirus induced reproductive disease is not possible on clinical grounds alone. Nevertheless, BVDV infection is clearly an important cause of economic loss in the Australian cattle industries. The number of cases identified during this project is probably higher than might have been expected at the start of the project. The higher rate of confirmation compared to leptospirosis and campylobacter infection is interesting, but vaccines are available for both of these bacterial diseases.

Although there has been an improved level of knowledge of pestivirus infection in the veterinary profession in recent years, there is clearly still a need for further education. Education needs to be directed at both clinical recognition and diagnosis of BVDV infection. At the laboratory level, there is also scope for improvement, especially in the use of serology for incrimination of BVDV in reproductive disease. Attention needs to be directed at the types of tests employed and their interpretation. The investigation of respiratory disease can be improved at both a field and laboratory level.

There is clearly an increasing conflict in some states between the need for veterinarians to provide information relevant to an investigation and the obligation placed on a client to pay for some or all of the laboratory tests. This has clearly restricted the use of diagnostic veterinary laboratories and the flow of information for "passive" disease surveillance. These problems appear to be greatest in states where private laboratories are major service providers. There is clearly a need for an improvement in the provision of information from private pathology laboratories when referring specimens to government laboratories. However, the tendency for government laboratories to charge for tests, despite the inherent value of passive surveillance data, severely restricts any "leverage" than can be applied to provide information.

An education program must be provided for both veterinarians and farmers when BVDV vaccines are launched in Australia. This is important to ensure that there is appropriate use of the products to ensure maximum efficacy and to minimise the emergence of “escape” mutants and hence prolong the “life” of the products.

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# APPENDICES

## Table 4: Accessions with BVDV Testing

| Syndrome | NSW | | | NT | | | QLD | | | SA | | | VIC | | | WA | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | BVDV | | Total | BVDV | | Total | BVDV | | Total | BVDV | | Total | BVDV | | Total | BVDV | | Total | BVDV | |
| | | (No) | (%) | | (No) | (%) | | (No) | (%) | | (No) | (%) | | (No) | (%) | | (No) | (%) | | (No) | (%) |
| **Reproductive** | | | | | | | | | | | | | | | | | | | | | |
| Abortion | 71 | 13 | 18.3 | 0 | 0 | 0.0 | 89 | 10 | 11.2 | 5 | 1 | 20.0 | 12 | 0 | 0.0 | 51 | 16 | 31.4 | 228 | 40 | 17.5 |
| Empty | 25 | 10 | 40.0 | 3 | 0 | 0.0 | 52 | 9 | 17.3 | 0 | 0 | 0.0 | 0 | 0 | 0.0 | 15 | 3 | 20.0 | 95 | 22 | 23.2 |
| Fail to calve | 10 | 4 | 40.0 | 0 | 0 | 0.0 | 25 | 6 | 24.0 | 4 | 1 | 25.0 | 1 | 1 | 100.0 | 2 | 0 | 0.0 | 42 | 12 | 28.6 |
| Return | 9 | 4 | 44.4 | 0 | 0 | 0.0 | 10 | 0 | 0.0 | 1 | 0 | 0.0 | 1 | 0 | 0.0 | 2 | 1 | 50.0 | 23 | 5 | 21.7 |
| Stillborn | 36 | 4 | 11.1 | 1 | 0 | 0.0 | 25 | 6 | 24.0 | 11 | 6 | 54.5 | 8 | 2 | 25.0 | 14 | 5 | 35.7 | 95 | 23 | 24.2 |
| **Total** | **151** | **35** | **23.2** | **4** | **0** | **0.0** | **201** | **31** | **15.4** | **21** | **8** | **38.1** | **22** | **3** | **13.6** | **84** | **25** | **29.8** | **483** | **102** | **21.1** |
| **Weaner** | | | | | | | | | | | | | | | | | | | | | |
| Death | 14 | 5 | 35.7 | 1 | 0 | 0.0 | 4 | 1 | 25.0 | 1 | 0 | 0.0 | 9 | 1 | 11.1 | 5 | 1 | 20.0 | 34 | 8 | 23.5 |
| Enteritis | 23 | 6 | 26.1 | 2 | 0 | 0.0 | 12 | 3 | 25.0 | 4 | 0 | 0.0 | 46 | 14 | 30.4 | 4 | 1 | 25.0 | 91 | 24 | 26.4 |
| Illthrift | 41 | 10 | 24.4 | 2 | 0 | 0.0 | 41 | 12 | 29.3 | 3 | 1 | 33.3 | 15 | 4 | 26.7 | 9 | 0 | 0.0 | 111 | 27 | 24.3 |
| Multiple | 9 | 7 | 77.8 | 0 | 0 | 0.0 | 7 | 1 | 14.3 | 1 | 0 | 0.0 | 3 | 0 | 0.0 | 3 | 1 | 33.3 | 23 | 9 | 39.1 |
| Pneumonia | 13 | 3 | 23.1 | 1 | 0 | 0.0 | 15 | 3 | 20.0 | 2 | 1 | 50.0 | 6 | 0 | 0.0 | 6 | 0 | 0.0 | 43 | 7 | 16.3 |
| **Total** | **100** | **31** | **31.0** | **6** | **0** | **0.0** | **79** | **20** | **25.3** | **11** | **2** | **18.2** | **79** | **19** | **24.1** | **27** | **3** | **11.1** | **302** | **75** | **24.8** |
| **Yearling/Adult** | | | | | | | | | | | | | | | | | | | | | |
| Death | 4 | 1 | 25.0 | 0 | 0 | 0.0 | 0 | 0 | 0.0 | 0 | 0 | 0.0 | 2 | 1 | 50.0 | 2 | 2 | 100.0 | 8 | 4 | 50.0 |
| Mucosal Dis. | 18 | 9 | 50.0 | 1 | 0 | 0.0 | 9 | 3 | 33.3 | 3 | 0 | 0.0 | 8 | 3 | 37.5 | 8 | 4 | 50.0 | 47 | 19 | 40.4 |
| Other | 8 | 0 | 0.0 | 2 | 2 | 100.0 | 4 | 1 | 25.0 | 0 | 0 | 0.0 | 6 | 0 | 0.0 | 6 | 2 | 33.3 | 26 | 5 | 19.2 |
| Pneumonia | 8 | 3 | 37.5 | 0 | 0 | 0.0 | 11 | 1 | 9.1 | 0 | 0 | 0.0 | 6 | 0 | 0.0 | 6 | 1 | 16.7 | 31 | 5 | 16.1 |
| Scouring | 33 | 8 | 24.2 | 0 | 0 | 0.0 | 26 | 8 | 30.8 | 4 | 0 | 0.0 | 13 | 0 | 0.0 | 13 | 5 | 38.5 | 89 | 21 | 23.6 |
| Wasting | 41 | 11 | 26.8 | 5 | 0 | 0.0 | 43 | 9 | 20.9 | 4 | 0 | 0.0 | 6 | 0 | 0.0 | 6 | 2 | 33.3 | 105 | 22 | 21.0 |
| **Total** | **112** | **32** | **28.6** | **8** | **2** | **25.0** | **93** | **22** | **23.7** | **11** | **0** | **0.0** | **41** | **4** | **9.8** | **41** | **16** | **39.0** | **306** | **76** | **24.8** |
| **Grand Total** | **363** | **98** | **27.0** | **18** | **2** | **11.1** | **373** | **73** | **19.6** | **43** | **10** | **23.3** | **142** | **26** | **18.3** | **152** | **44** | **28.9** | **1091** | **253** | **23.2** |

## Table 5: Accessions with BVDV Testing (Beef Cattle)

| Syndrome | NSW | | | NT | | | QLD | | | SA | | | VIC | | | WA | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | BVDV | | Total | BVDV | | Total | BVDV | | Total | BVDV | | Total | BVDV | | Total | BVDV | | Total | BVDV | |
| **Reproductive** | | (No) | (%) | | (No) | (%) | | (No) | (%) | | (No) | (%) | | (No) | (%) | | (No) | (%) | | (No) | (%) |
| Abortion | 52 | 13 | 25.0 | 0 | 0 | 0.0 | 48 | 8 | 16.7 | 2 | 0 | 0.0 | 9 | 0 | 0.0 | 31 | 11 | 35.5 | 142 | 32 | 22.5 |
| Empty | 22 | 9 | 40.9 | 3 | 0 | 0.0 | 52 | 9 | 17.3 | 0 | 0 | 0.0 | 0 | 0 | 0.0 | 13 | 3 | 23.1 | 90 | 21 | 23.3 |
| Fail to calve | 10 | 4 | 40.0 | 0 | 0 | 0.0 | 27 | 6 | 22.2 | 4 | 1 | 25.0 | 1 | 1 | 100.0 | 2 | 0 | 0.0 | 44 | 12 | 27.3 |
| Return | 4 | 2 | 50.0 | 0 | 0 | 0.0 | 8 | 0 | 0.0 | 0 | 0 | 0.0 | 1 | 0 | 0.0 | 1 | 0 | 0.0 | 14 | 2 | 14.3 |
| Stillborn | 33 | 3 | 9.1 | 1 | 0 | 0.0 | 25 | 5 | 20.0 | 10 | 6 | 60.0 | 6 | 2 | 33.3 | 11 | 4 | 36.4 | 86 | 20 | 23.3 |
| **Total** | **121** | **31** | **25.6** | **4** | **0** | **0.0** | **160** | **28** | **17.5** | **16** | **7** | **43.8** | **17** | **3** | **17.6** | **58** | **18** | **31.0** | **376** | **87** | **23.1** |
| **Weaner** | | | | | | | | | | | | | | | | | | | | | |
| Death | 11 | 5 | 45.5 | 1 | 0 | 0.0 | 3 | 1 | 33.3 | 1 | 0 | 0.0 | 6 | 1 | 16.7 | 5 | 1 | 20.0 | 27 | 8 | 29.6 |
| Enteritis | 20 | 5 | 25.0 | 2 | 0 | 0.0 | 12 | 3 | 25.0 | 4 | 0 | 0.0 | 43 | 13 | 30.2 | 2 | 1 | 50.0 | 83 | 22 | 26.5 |
| Illthrift | 35 | 9 | 25.7 | 2 | 0 | 0.0 | 39 | 12 | 30.8 | 3 | 1 | 33.3 | 14 | 3 | 21.4 | 7 | 0 | 0.0 | 100 | 25 | 25.0 |
| Multiple | 8 | 7 | 87.5 | 0 | 0 | 0.0 | 7 | 1 | 14.3 | 1 | 0 | 0.0 | 2 | 0 | 0.0 | 3 | 1 | 33.3 | 21 | 9 | 42.9 |
| Pneumonia | 13 | 3 | 23.1 | 1 | 0 | 0.0 | 10 | 2 | 20.0 | 2 | 1 | 50.0 | 4 | 0 | 0.0 | 3 | 0 | 0.0 | 33 | 6 | 18.2 |
| **Total** | **87** | **29** | **33.3** | **6** | **0** | **0.0** | **71** | **19** | **26.8** | **11** | **2** | **18.2** | **69** | **17** | **24.6** | **20** | **3** | **15.0** | **264** | **70** | **26.5** |
| **Yearling/Adult** | | | | | | | | | | | | | | | | | | | | | |
| Death | 4 | 1 | 25.0 | 0 | 0 | 0.0 | 0 | 0 | 0.0 | 0 | 0 | 0.0 | 1 | 1 | 100.0 | 2 | 2 | 100.0 | 7 | 4 | 57.1 |
| Mucosal Dis. | 17 | 9 | 52.9 | 1 | 0 | 0.0 | 8 | 3 | 37.5 | 3 | 0 | 0.0 | 6 | 2 | 33.3 | 7 | 3 | 42.9 | 42 | 17 | 40.5 |
| Other | 7 | 0 | 0.0 | 2 | 2 | 100.0 | 3 | 1 | 33.3 | 0 | 0 | 0.0 | 4 | 0 | 0.0 | 4 | 1 | 25.0 | 20 | 4 | 20.0 |
| Pneumonia | 7 | 3 | 42.9 | 0 | 0 | 0.0 | 9 | 1 | 11.1 | 0 | 0 | 0.0 | 2 | 0 | 0.0 | 3 | 1 | 33.3 | 21 | 5 | 23.8 |
| Scouring | 29 | 8 | 27.6 | 0 | 0 | 0.0 | 23 | 8 | 34.8 | 4 | 0 | 0.0 | 7 | 0 | 0.0 | 11 | 4 | 36.4 | 74 | 20 | 27.0 |
| Wasting | 40 | 10 | 25.0 | 5 | 0 | 0.0 | 41 | 9 | 22.0 | 4 | 0 | 0.0 | 2 | 0 | 0.0 | 5 | 2 | 40.0 | 97 | 21 | 21.6 |
| **Total** | **104** | **31** | **29.8** | **8** | **2** | **25.0** | **84** | **22** | **26.2** | **11** | **0** | **0.0** | **22** | **3** | **13.6** | **32** | **13** | **40.6** | **261** | **71** | **27.2** |
| **Grand Total** | **312** | **91** | **29.2** | **18** | **2** | **11.1** | **315** | **69** | **21.9** | **38** | **9** | **23.7** | **108** | **23** | **21.3** | **110** | **34** | **30.9** | **901** | **228** | **25.3** |

## Table 6: Incidence of BVDV infection in Defined Syndromes in Beef Cattle Relative to Cattle Numbers

| Syndrome | NSW | | NT | | QLD | | SA | | VIC | | WA | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cases | Rate* | Cases | Rate | Cases | Rate | Cases | Rate | Cases | Rate | Cases | Rate | Cases | Rate |
| Reproductive | 121 | 2.013 | 4 | 0.232 | 160 | 1.417 | 16 | 1.408 | 17 | 0.638 | 58 | 2.786 | 376 | 1.482 |
| Weaner | 87 | 1.447 | 6 | 0.348 | 71 | 0.629 | 11 | 0.968 | 69 | 2.591 | 20 | 0.961 | 264 | 1.041 |
| Adult | 104 | 1.730 | 8 | 0.465 | 84 | 0.744 | 11 | 0.968 | 22 | 0.826 | 32 | 1.537 | 261 | 1.029 |
| | | | | | | | | | | | | | | |
| Total | 312 | 5.190 | 18 | 1.045 | 315 | 2.790 | 38 | 3.345 | 108 | 4.056 | 110 | 5.283 | 901 | 3.551 |
| | | | | | | | | | | | | | | |
| Syndrome | BVDV | | BVDV | | BVDV | | BVDV | | BVDV | | BVDV | | BVDV | |
| | No | Rate** | No | Rate | No | Rate | No | Rate | No | Rate | No | Rate | No | Rate |
| Reproductive | 31 | 0.516 | 0 | 0.000 | 28 | 0.248 | 7 | 0.616 | 3 | 0.113 | 18 | 0.865 | 87 | 0.343 |
| Weaner | 29 | 0.482 | 0 | 0.000 | 19 | 0.168 | 2 | 0.176 | 17 | 0.638 | 3 | 0.144 | 70 | 0.276 |
| Adult | 31 | 0.516 | 2 | 0.116 | 22 | 0.195 | 0 | 0.000 | 3 | 0.113 | 13 | 0.624 | 71 | 0.280 |
| | | | | | | | | | | | | | | |
| Total | 91 | 1.514 | 2 | 0.116 | 69 | 0.611 | 9 | 0.792 | 23 | 0.864 | 34 | 1.633 | 228 | 0.899 |
| | | | | | | | | | | | | | | |
| Beef Cattle Nos | 6012 | | 1722 | | 11289 | | 1136 | | 2663 | | 2082 | | 25372 | |

* Number of cases of the relevant syndrome per 1,000 beef cattle in the specified state

** Number of cases of the respective syndrome due to BVDV infection per 1,000 beef cattle in the specified state

# Appendix 1 – Questionnaire for Telephone Interviews of Veterinarians

## MLA Bovine Pestivirus Project – Practitioner Knowledge Survey

State District

Year of Graduation Vet School

Employment Type: Private (Principal/Other/Practice type – mixed/specialist incl consultants)

Government

Pastoral Co

Other (specify)

1. a) Do you recognise bovine pestivirus by any other name?

   b) If so, what?

2. What clinical syndromes do you believe that bovine pestivirus can cause worldwide?

   a) Reproductive disease

   b) Respiratory disease

   c) Immunosuppression

   d) Enteritis

   e) Haemorrhagic disease

   f) Mucosal disease

   g) Illthrift

3. Do you think bovine pestivirus in Australia can be a significant cause of:

   a) Early reproductive loss (conception failure)?

   b) Abortion?

   c) Congenital defects?

      i) What defects have you observed?

   d) Stillbirths/early calf deaths?

   e) Calf pneumonia?

   f) Weaner illthrift

   g) Yearling mortality

   h) Respiratory disease in feedlot cattle

   i) Haemorrhagic disease and/or acute enteritis

4. Are your cattle clients aware of this virus?

5. In addition to cattle, can any other species of livestock be infected?

6. Do you suspect or diagnose pestivirus infections in cattle:

   a) Never

   b) Rarely

   c) Occasionally

   d) Often

7. Do you seek laboratory confirmation of bovine pestivirus infections?

a) Never

b) Rarely

c) Occasionally

d) Often

8. To what extent do laboratory charging policies influence your submission of specimens for pestivirus examination (for disease diagnosis)?

9. What specimens would you collect for the diagnosis of pestivirus as the cause of:

a) poor conception rates (not in calf at pregancy testing)

b) abortion or low calving percentage in cattle that were believed to be in calf (PTIC)?

b) weaner illthrift

c) pneumonia in feedlot cattle:

(i) Live

(ii) Dead

d) Mucosal disease (acute or chronic)

10. In the absence of vaccines, do you recommend any methods to control pestivirus infection?

11. If there was a pestivirus vaccine available, would you recommend its use?

12. How would you recommend that an inactivated pestivirus vaccine be used in a breeding herd?