final report: appendices

Project code: W.LIV.0252

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Identifying the Causes of Mortality in Cattle Exported to the Middle East: Appendices to the final report

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1 Appendix 1: Review of job description for Australian Government Accredited Veterinarians (AAVs)

1.1 Introduction

This report was written by the following members of the project team: Michael McCarthy, Leisha Hewitt, Tristan Jubb, Robyn Tynan and Nigel Perkins.

The report was completed in October 2009.

This report was intended to deliver against Objective 4: Responsibilities of on-board vets and stockpersons, from the Stage 1 task list for the project.

While the report is focused on responsibilities for AAV we recognise that where there is no AAV on board a ship, there may be a need for some of these tasks to be assigned to the senior stockperson. The requirement for an AAV to accompany a voyage is made by the Secretary of the Department of Agriculture as part of the Approved Export Plan (AEP). In fact, as the project developed and voyages were enrolled, all voyages that participated in the study were accompanied by an AAV. As a result we did not have to specifically task stockpersons with a leadership role for project data collection.

This report provided the basis for discussion with exporters and AAVs about involvement of AAVs in research activities and developing agreement on the scope of activities that AAVs might be able to undertake for the research project while ensuring that AAVs were not asked to do anything that was not already in their routine voyage responsibilities.

1.2 Current tasks and obligations

1.2.1 Prerequisites

On-board veterinarians must meet the following eligibility criteria:

- be registered by a State/Territory veterinary surgeon's board;
- be an Australian citizen in order to accompany an export ship to overseas destinations (not required for approval for pre-embarkation activities);
- have completed Animal Health Australia's Accreditation Program for Australian Veterinarians (APAV)[1];
- have successfully completed the AQIS Accredited Veterinarian (AAVET) course[2];
- have submitted to AQIS a completed form titled Application for Accreditation of Veterinarians for Live-stock Export (AAV-250609).

1.2.2 Tasks and reporting

During a voyage, the AAV is required to produce a daily report and an end-of-voyage report and the contents of those two reports are defined in both the Export Control (Animals) Order 2004 and the ASEL. These reporting requirements are defined in a document titled Approved Export Program (AEP) that is linked to the NOI/CRMP for that voyage and that specifies the vessel, importing country, species, class, breed and estimated departure date.

There may also be pre-export reporting requirements for the AAV, generally associated with preparing the animals/consignment for export and including identification of animals, samples for testing, treatments, inspections, rejections etc.

[1] http://www.animalhealthaustralia.com.au/training/apav.cfm

[2] http://www.animalhealthaustralia.com.au/aahc/index.cfm?E984B958-D7BB-A8D3-3AC3-93F0FBEB593E

The AAV may have additional duties defined in the contract between the AAV and the exporter and these are likely to include assisting with loading and discharge, and various tasks identified under instructions provided to the Captain/Veterinarian/Stockperson that relate to care of animal health and welfare during the voyage. The AAV is generally required to undertake tasks as instructed by the Exporter and the Ship's Master (Captain) and it is understood that the Master is responsible under law for the welfare of livestock on board the vessel.

The AAV is expected to provide health and welfare care for the livestock including identification and management of welfare threats and managing and treating sick or weak animals (including euthanasia if required).

There may be general obligations relating to terms of employment during the voyage including general conduct and behaviour, hours worked and various duties and obligations.

1.2.3 Summary of current tasks/roles

- To provide independent reporting to AQIS in keeping with the statutory requirements of ASEL.
- Maintain an overview of the provision of adequate livestock services (fodder, water and ventilation) in keeping with the statutory requirements of AMSA.
- Maintain an overview of the management of all the livestock on board the vessel.
- Provide care and husbandry to specific groups of livestock within the consignment (as directed by the exporter).
- Identify, remove and/or provide appropriate treatment to sick animals within these specified groups of animals.
- Oversee the treatment of sick animals in the consignment as a whole.
- Ensure that sick or injured animals that are judged to be unlikely to recover are euthanized in a humane manner.
- Conduct post mortems where required/appropriate.
- Provide feedback, where possible (in terms of ear tag details (owner id), lines, mobs etc) to the exporter in relation to deaths, calves/lambs or any other conditions of interest to the exporter.
- Participate in daily meetings to discuss any matters relating to the management of the livestock on board.
- Ensure familiarity with strategic documents such as ASEL, the stockman's handbook, importing country health requirements, pre-export protocols relating to the consignment etc.
- Assist in the loading and discharge of livestock where appropriate.
- Represent the exporter on any issues relating to the husbandry and welfare of the livestock on board.
- Identify issues, problems etc in addition to any suggestions that may contribute to the continuous improvement of the care and husbandry of the livestock on board and relay these on to the exporter.

1.3 Additional roles developed through W.LIV0252

The additional roles and activities being considered as part of this project involved collection of simple data and information to allow better determination of causes of mortality and morbidity. The intent was to develop simple systems that minimized any additional burden on the AAV and maximized the potential for collection of simple information to describe patterns of morbidity and mortality, causes of mortality and to assist in identification of potential causes of morbidity and mortality.

An important aim of this activity was to ensure that any tasks intended to be completed by the AAV for the purposes of this research project (W.LIV.0252) should not be considered to be additional or new activities when compared to routine job responsibilities for AAVs. The tasks should relate to activities that AAVs are already required to perform i.e. provide care for livestock and record morbidity and mortality and treatments.

Any changes in responsibilities were more likely to be related to how such data and information might be recorded and used and how causes of death can be more accurately determined through post mortem procedures and collection of samples for examination by pathologists.

Activities of particular interest to W.LIV.0252 included:

- Conducting a thorough post mortem on most or all cattle mortalities throughout the voyage (in keeping with the instructions provided in the Veterinarians Handbook produced under Objective 1 of the current project). It is expected that not all deaths will be subjected to a post mortem because of constraints over performing such procedures in certain locations such as near ports or land and in cases where it is not physically possible to perform a post mortem on all animals.
- Collecting appropriate samples (in keeping with the instructions provided by the veterinary handbook – see Objective 1 of the current project).
- Arranging for the proper packaging and repatriation of samples (in keeping with the instructions provided by the veterinary handbook – see Objective 1 of the current project).
- Keeping a copy of all daily and end of voyage reports (it was not possible to obtain copies of daily or end of voyage reports during this project because of concerns over release of sensitive information).
- Collecting data and information on morbidity and mortality as defined in Objective 1 and 2 of this project.
- Managing a veterinary kit during the project. Objective 3 involves the development of specifications for a kit to accompany voyages and provide equipment and sample collection containers to allow effective post mortem and sampling of sick and dead animals. At the end of the voyage the kit will need to be cleaned and assessed to determine what items need to be replaced.

1.4 Skills required

1.4.1 General attributes:

- Physically fit.
- Good interpersonal skills.
- Data management/record keeping/reporting skills.
- “Sea legs”.

1.4.2 Essential skills and knowledge:

- Awareness of the common syndromes, diseases and conditions that cause death in live export cattle including what they look like, what to look for and the theoretical risk factors predisposing to their occurrence.
- Awareness of the safety and hygiene precautions required to prevent injury or infection (with a zoonotic agent) when handling, examining and sampling sick animals.
- Age cattle by their teeth.
- Make systematic and accurate individual animal (within-group) and group-level observations and comparisons of cattle.
- Recognise and interpret abnormal clinical signs.

- Recognise existing active risk factors operating on board that are predisposing to disease occurrence and death.
- Systematically collect a history and conduct a necropsy.
- Recognise, describe and interpret abnormal gross necropsy changes.
- Know where to find a list of samples to collect during necropsies from cattle showing different symptoms.
- Collect good quality representative samples according to the protocol and store the samples.
- Provide a tentative diagnosis and differential diagnoses based on history, gross necropsy findings and presence of risk factors.
- Satisfactorily complete a Necropsy Report.
- Use and maintain a captive bolt gun.
- Assess effective stunning and killing.
- Remove a brain using the longitudinal craniotomy method.
- Sharpen a knife using a stone and steel.
- Use the various health indices available on board including food and water consumption, drug usage and hospital pen records to measure amount and impact of different diseases and conditions.
- Understand the system for daily collection and pooling of observational data from stockpersons to form the basis for a description of animal health on a daily basis during voyages.
- Accurately complete a Sick Cattle Sample Submission Form so that the information is usable by a laboratory diagnostician and contributes useful epidemiological data.
- Accurately complete a Sick Cattle Epi Report that contributes useful epidemiological data.
- Disinfect and package samples for the return voyage.

1.4.3 Experience:

- Experience working with large animals.
- Post mortem experience.
- Pathology sample collection.
- Shipboard experience.

1.5 Reporting requirements during a voyage

There is a requirement for AAVs to submit a daily voyage report and an end of voyage report to the Commonwealth Department of Agriculture.

Relevant sections of the regulatory framework include:
- Section 4A. 15 of the *EC (Animals) Order 2004*;
- ASEL S5.12 and S5.13.

The Commonwealth Department of Agriculture website provides templates for the daily voyage report and end of voyage report indicating the information that must be provided in each report. [3]

Figures 1 and 2 show the template daily and end of voyage reports available for download from the Department of Agriculture website.

[3] http://www.agriculture.gov.au/biosecurity/export/live-animals/livestock/information-exporters-industry/forms

Australian Government
Department of Agriculture

Daily Voyage Report

This form is authorised under 4A.15 of the Export Control (Animal) Orders 2004

This is the appropriate daily report for an Australian Government Accredited Veterinarian to complete on an export voyage and supply to the Department of Agriculture. For voyages where a veterinarian is not on board, the accredited Stock Person must provide the daily report to the Department of Agriculture.

1. VOYAGE DETAILS

Australian Government Accredited Veterinarian / Accredited Stock Person	Date
Exporter	**Vessel**
Vessel position and ETA at next Port	**Voyage #**
Destination Port/s	**Day of Voyage***

** Day number must be consistent with the day number used by the Master of the Vessel*

2. REPORT

Please attach the following information:

1. Numbers of each species of livestock loaded at each port
2. Daily recordings:
   - average dry bulb and wet bulb temperature for each deck
   - humidity for each deck
   - bridge temperature (ambient)
3. Feed and water consumption – average per head
4. Health and welfare issues – hospital pen report including medication and treatments
5. Births and abortions (including estimated stage of pregnancy)
6. Respiratory rate and character (1 = normal, 2 = panting, 3 = gasping)
7. Whether and to what extent the livestock show heat stress
8. Faeces – average for each cattle deck (1 = normal, 2 = sloppy, 3 = runny diarrhoea, 4 = like sheep pellets)
9. Issues from daily meeting
10. Mortality
    - Daily and cumulative mortality for each class of livestock and deck
    - Comment on cause of mortality
11. General conditions and comments including the deck conditions
12. Any other relevant matter

3. VETERINARIAN / STOCK PERSON DECLARATION (delete as required)

I declare that the information that I have provided is true and accurate to the best of my knowledge.

Signature: _____ **Date** ___/___/___

Name: _____

The daily voyage report should be submitted to:
Department of Agriculture
Animal Export Operations
Email: Livestockexp@daff.gov.au
Fax: 02 6272 5423

DEPARTMENT OF AGRICULTURE

LDV-250314

Figure 1: Daily voyage report template. Available at http://www.agriculture.gov.au/biosecurity/export/live-animals/livestock/information-exporters-industry/forms. Accessed 5 Feb 2015.

Australian Government
Department of Agriculture

End of Voyage Report
(Sea Transport)

This is the appropriate report for an accredited veterinarian to complete at the end of an export voyage and supply to the Department of Agriculture. For voyages where a veterinarian is not on board, the accredited Stock Person must provide the end of journey report to the Department of Agriculture.

1. Voyage details

Australian Government Accredited Veterinarian / Accredited Stock Person

Date

Exporter

Voyage No. of Days

Vessel Name

Voyage #

Departure Port(s)

Destination Port(s)

2. Report

This report must provide a general overview of the voyage, with mention of any specific issues relevant to the health and welfare of the livestock, and must include the following information:

1. Port or ports at which the loading took place:
   - The date the loading of the live-stock was completed at each port
   - Numbers of each species of livestock loaded at each port
2. The port or ports at which the live-stock were discharged:
   - The dates the live-stock were discharged at each port
   - Numbers of each species of livestock discharged at each port
3. Mortality – the total and percentage mortality for each species and class of livestock and the total and percentage mortality for each deck of the vessel
4. Feed and water – comment on stock access and if there were any issues with maintenance
5. Environmental conditions – comment on weather, temperature, humidity, ventilation and decks / bedding
6. Health and welfare of the livestock
   - the number of livestock born, the number of abortions and estimated stage of pregnancy
   - any treatments given to the livestock during the voyage
7. Relationships with the Master / crew / accredited stockperson / accredited veterinarian
8. Comments on discharge operations
9. Anything else relevant to the live-stock during the voyage

3. Veterinarian / Stock Person Declaration (delete as required)

I declare that the information that I have provided is true and accurate to the best of my knowledge.

Signature: _____ **Date** ___/___/___

Name:

The end of voyage report should be submitted to:
Department of Agriculture
Animal Export Operations Branch
Email: Livestockexp@daff.gov.au
Fax: 02 6272 5423

DEPARTMENT OF AGRICULTURE

LEV-250314

Figure 2: End of voyage report template. Available at http://www.agriculture.gov.au/biosecurity/export/live-animals/livestock/information-exporters-industry/forms. Accessed 5 Feb 2015.

1.6 Records that must be kept by a shipboard AAV

The following text is taken from the *Export Control (Animals) Order 2004*. [4] This section is interpreted as relevant to records associated with veterinary activities prior to animal being loaded onto a vessel at an Australian port.

4A.14 Accredited veterinarians to keep certain records

(1) The accredited veterinarian nominated by an exporter to undertake an approved export program must keep records of the following in relation to the program:

(a) if the veterinarian administers or supervises any veterinary examination or treatment, or testing, of the live-stock to be exported:

(i) what the examination, treatment or testing was; and

(ii) the date on which, and the place at which, it was administered or supervised;

(b) in relation to a treatment involving the administration of a drug or product:

(i) the name of the active constituent in the drug or product; and

(ii) the dosage of the drug or product given to the live-stock;

(c) the results of any testing undertaken;

(d) pre-export quarantine or isolation of the live-stock, including the length and conditions of the quarantine or isolation;

(e) sufficient information to identify (either generally or specifically, as required by the relevant importing country protocol) the live-stock examined, treated, tested, or subjected to pre-export quarantine or isolation.

Note: Failure to keep such a record is an offence—see the Act, subsection 9G(1).

(2) The accredited veterinarian must also keep the invoice received upon purchase for a drug or product administered to the live-stock.

(3) The accreditation of a veterinarian is subject to the following conditions:

(a) that he or she must keep copies of all documents given to him or her in connection with a consignment of live-stock for at least 2 years after the consignment leaves the premises at which they are held and assembled for export;

(b) that if the Secretary so requests in writing, he or she must produce to the Secretary any document referred to in paragraph (a), and specified or described in the request, within 14 days of the request, or such lesser period as the Secretary may specify.

[4] http://www.comlaw.gov.au/Details/F2014C01265. Accessed 5 Feb 2015.

4A.15 Reports by accredited veterinarians on voyages

(1) If the accredited veterinarian nominated by an exporter to undertake an approved export program travels with the live-stock on the export voyage, the veterinarian must make a written report to the Secretary, in the form approved by the Secretary for the purpose.

Note: Failure to make such a report is an offence—see the Act, subsection 9G(1).

(2) The veterinarian must make the report daily unless the Secretary directs the veterinarian in writing otherwise.

(3) The approved form may require information about the following matters:

(a) the temperature on board the vessel;
(b) the humidity on board the vessel;
(c) the wet bulb readings;
(d) the deck or cargo hold conditions;
(e) the general conditions;
(f) the respiratory rate and character of the live-stock;
(g) whether and to what extent the live-stock show heat stress;
(h) the feed and water consumption of the live-stock;
(i) a hospital pen report;
(j) mortality rates;
(k) number of live-stock that gave birth and estimated stage of pregnancy at time of giving birth for each birth;
(l) any other relevant matter.

(4) Within 5 working days after the end of the voyage, the veterinarian must make a written report to the Secretary, in the form approved by the Secretary for the purpose, setting out:

(a) the name of the exporter; and
(b) the month and year in which the loading of the live-stock was completed; and
(c) the port or ports at which the loading took place; and
(d) the port or ports at which the live-stock were discharged; and
(e) the month and year in which the live-stock were discharged at each port; and
(f) the duration of the voyage; and
(g) the type or types of live-stock; and
(h) the number of each type of live-stock loaded; and
(i) the total mortality for each type of live-stock; and
(j) the percentage mortality for each type of live-stock; and
(k) the health and welfare of the live-stock on the voyage; and
(l) number of live-stock that gave birth and summary information in relation to the estimated stage of pregnancy at the time of birth for those births; and
(m) any treatment given to the live-stock during the voyage; and
(n) anything else relevant to the live-stock during the voyage.

Note: Failure to make such a report is an offence—see the Act, subsection 9G(1).

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2 Appendix 2: Training needs assessment

2.1 Introduction

This report was written by the following members of the project team: Tristan Jubb, Michael McCarthy and Leisha Hewitt.

The report was completed in September 2009.

This report was intended to deliver against Objective 5: Review training material and training activities for accredited veterinarians and stockpersons to ensure that relevant information from Objectives 1 to 4 are covered. It was intended to review current practices operating in the export industry.

The training needs assessment was one of the first activities completed for the project. The W.LIV.0252 project was designed to have accredited veterinarians (AAVs) systematically following standardised disease investigation and data collection procedures on board cattle ships.

At the time this training needs assessment was done the project team was early in the process of developing protocols and procedures for the project. There was interest in understanding roles and responsibilities and training needs for both AAVs and stockpersons for two reasons. The first was that we recognised that stockpersons may assist AAVs in collecting observations on morbidity and mortality and may also assist in doing necropsies. The second was that in the event that a voyage enrolled in the study was not accompanied by an AAV then we needed to be prepared to have the senior stockperson acting as the collector of project-relevant data and information. As it turned out, all enrolled voyages were accompanied by an AAV and all project responsibilities were assigned to the AAV. In many cases the AAVs routinely seek assistance from stockpersons on board the ship and at an informal level stock persons did contribute to the data collection processes.

It was recognised that some level of training would be required to achieve this even though most veterinarians and stockpersons will have had some *ad hoc* and on-the-job training and experience. They will have participated in disease investigations and gathering of animal health data for the mandatory daily and end of trip, voyage reports.

This report aimed to produce a training needs assessment of accredited veterinarians and stockpersons participating in disease investigations on cattle ships.

Completion of this report required a number of questions to be answered including:

- What skills and knowledge are required to deliver the tasks to the required standard
- What are the existing skills and knowledge among accredited veterinarians and stockpersons
- What training courses and materials are already available
- What constraints are there to running training, and
- What are the training options

This training needs analysis attempts to provide answers to these questions under the headings below.

2.2 Skills and knowledge requirements

The skills and knowledge requirements are those necessary for servicing the disease investigation and data collection protocols developed for W.LIV.0252 and more broadly to meet the requirements for routine data collection during voyages agreed between industry and Government (described in Appendix 1).

Because the skills and knowledge required for satisfactorily investigating disease events are different for investigation of sickness compared to investigating death, they are listed separately.

2.2.1 Skills and knowledge of veterinarians and stockpersons investigating deaths

1. Awareness of the common syndromes, diseases and conditions that cause death in live export cattle including what they look like, what to look for and the theoretical risk factors predisposing to their occurrence.
2. Awareness of the safety and hygiene precautions required to prevent injury or infection (with a zoonotic agent) when handling, examining and sampling sick animals.
3. Systematically collect a history and conduct a necropsy
4. Recognise, describe and interpret abnormal gross necropsy changes
5. Recognise the risk factors operating on board that predispose to death
6. Know where to find a list of samples to collect during necropsies from cattle showing different symptoms
7. Collect good quality representative samples according to the protocol and store the samples
8. Provide a tentative diagnosis and differential diagnoses based on history, gross necropsy findings and presence of risk factors
9. Satisfactorily complete a Necropsy Report
10. Use and maintain a captive bolt gun
11. Assess effective stunning and killing
12. Remove a brain using the longitudinal craniotomy method
13. Sharpen a knife using a stone and steel
14. Age cattle by their teeth

2.2.2 Skills and knowledge required of veterinarian or stockperson investigating sickness

1. Awareness of the common syndromes, diseases and conditions causing sickness in live export cattle including what they look like, what to look for and the theoretical risk factors predisposing to their occurrence.
2. Awareness of the safety and hygiene precautions required to prevent injury or infection (with a zoonotic agent) when handling, examining and sampling sick animals.
3. Make systematic and accurate individual animal (within-group) and group-level observations and comparisons of cattle
4. Recognise and interpret abnormal clinical signs

5. Recognise existing active risk factors operating on board that are predisposing to disease occurrence
6. Provide a tentative diagnosis and short list of differential diagnosis based on history, clinical signs and presence of risk factors.
7. Know where to find a list of samples required to be collected from cattle showing different symptoms
8. Collect good quality, representative samples according to a protocol and securely store the samples
9. Use the various health indices available on board including food and water consumption, drug usage and hospital pen records to measure amount and impact of different diseases and conditions.
10. Understand the system for daily collection and pooling of observational data from stockpersons to form the basis for a description of animal health on a daily basis during voyages.
11. Accurately complete a Sick Cattle Sample Submission Form so that the information is usable by a laboratory diagnostician and contributes useful epidemiological data.
12. Accurately complete a Sick Cattle Epi Report that contributes useful epidemiological data
13. Disinfect and package samples for the return voyage

2.3 Skills, knowledge, experience and attitudes of accredited veterinarians and stockpersons

2.3.1 Accredited veterinarians

The following profile of accredited veterinarians was formed after interviews with three experienced and active[5] accredited veterinarians, an exporter and managers from each of MLA, LiveCorp and Animal Health Australia with responsibilities for live cattle exports.

- There are less than 20 active accredited veterinarians that accompany cattle ships and another 50 or more that are accredited but appear to rarely accompany ships. To become accredited, veterinarians must complete an on-line training course focused mainly on legislative responsibilities of accredited veterinarians (details of the on-line training are provided below). Of the active veterinarians, six to eight are understood to work full time accompanying cattle ships while the remainder may accompany only one or two consignments per year.
- Considerable variability in skills, knowledge and experience exists - accredited veterinarians include recent graduates, small animal practitioners, experienced cattle practitioners or retired public servants or academics. Accordingly there is considerable variability in age, physical fitness, awareness of cross cultural issues, interpersonal skills and project management skills. Only one female veterinarian regularly accompanies cattle ships to the Middle East.
- Veterinarians are probably the best qualified generalists in animal welfare matters. However, there may be a need for some specialist knowledge when supervising livestock during sea voyages.
- The steady turnover of active accredited veterinarians with attrition estimated at 20 to 30% per year is associated with a similar stream of new inexperienced and untrained veterinarians replacing them.

[5] Active accredited veterinarians are those who regularly accompany cattle ships.

- Development of training materials that are easily able to be accessed by accredited veterinarians and that provide guidance, tips and tools on how to perform disease investigation-related tasks more safely, easily and with better results, is supported as a worthwhile investment in industry activities.
- Voluntary, well-run, interactive, hands-on training courses in which accredited veterinarians could actively participate and share their knowledge would be welcomed.
- In order for disease investigation protocols to be adequately serviced, the veterinarian, stockpersons and crew must work together as a team. This does not always happen easily as some new veterinarians, although clinically very competent, are not always able to engage the stockpersons and crew because the veterinarians are unfamiliar with their roles and responsibilities and how they should fit in. The first one or two voyages can be particularly difficult. For this reason a mentoring system is highly desirable.

2.3.2 Accredited stockpersons

The following profile of accredited stockpersons was formed after interviews with four experienced and active[6] accredited stockmen, an exporter and managers from each of MLA and LiveCorp with responsibilities for live cattle exports.

- There are over 350 accredited stockpersons for cattle boats but only about 80 are active. To become accredited, stockpersons must attend a training course (more details on stockman training are provided below). A mentoring system exists in that stockpersons must accompany two voyages (with satisfactory outcomes - as assessed by the shipboard veterinarian and the exporter) to become fully accredited.
- Stockpersons wishing to become accredited must provide a *curriculum vitae* to demonstrate numeracy and literacy skills and details of a sound background in handling livestock and a reference from an exporter or employer to support their claims in this area.
- As with veterinarians, interpersonal skills and ability to work in a cross cultural environment are important for stockpersons to work effectively on board and should be considered for inclusion in training. Similar to accredited veterinarians, stockpersons have no formal authority on board, therefore they must rely on developing good working relationships with the officers and crew on board, especially the Chief Officer and bosun if their advice is to be accepted and tasks they want done implemented.
- In order to work with the accredited veterinarian as a team and become involved with the veterinarian and ship's officers in major decisions concerning management of the cattle on board, the stockpersons must have a sound knowledge of animal health and welfare problems likely to be encountered and the principles of managing these problems. Therefore provision of this sound knowledge needs to be a priority in any stockman training program.
- Stockpersons want training in the areas of:
    - how to decide when to treat and how to treat an animal
    - how to decide when an animal should be euthanased
    - safe use, care and maintenance of spring loaded impact injection poles (ie Westerguns)
    - general knowledge of cattle health and welfare sufficient for stockpersons to work alone or to work as a team with the veterinarian and ship's officers

[6] Active accredited stockpersons are those who regularly accompany livestock ships.

2.4 Training course and materials currently available

Training courses and materials on subjects related to live exports are available to veterinarians and stockpersons, some aspects of which are useful to the systematic conduct of disease investigations on cattle ships needed by this project.

Stockpersons are not able to complete on-line AAV training because of the requirement that the candidate be a veterinary surgeon with current registration in an Australian State or Territory.

The training courses, materials and their relevance to systematic disease investigation are as follows:

2.4.1 On-line training to become an AQIS Accredited Veterinarian

This training course, managed by Animal Health Australia on behalf of AQIS, is designed to ensure the knowledge of and compliance with the legislative responsibilities by veterinarians working in the live export industry.

There are a series of modules – at the end of each is a quiz that if passed allows progression to the next module. The course takes approximately 6 hours to complete (including the assessment). Once the training course assessment is completed, veterinarians are deemed qualified (and designated as an Accredited AQIS Veterinarian) to perform various functions such as preparing and certifying cattle and accompanying livestock vessels in the live export trade. Included in the course are background information on the live export process and the information requirements for daily voyage reports for which some disease investigation skills are required, however there is no information on how to investigate disease events.

In addition to successful completion of the course, AAVet designation requires the veterinarian to be an Australian citizen, be registered by a state/territory veterinary surgeon's board and have completed Animal Health Australia's Accreditation program for Australian Veterinarians (APAV).

2.4.2 DVD - A Post-Mortem Technique for Cattle.

At the time this report was prepared there was a DVD available that provided 20 minutes of narrated footage of a post mortem examination. The DVD had been produced by LiveCorp in 2000, and was used in the Accredited Stockman Training.

The DVD is considered unsuitable for training in how to do a necropsy. It is short, the necropsy technique shown is awkward and incomplete and some of the information is misleading. For example, it is not shown how to open the thorax and the narrator describes how pneumonia is diagnosed by haemorrhages in the lungs and froth in the airways, which is incorrect.

There is also nothing on personal protective, dissection and sampling equipment required or how to collect specimens.

The footage is however useful for lay persons needing introductory training on identifying organs and recognising normal appearance.

There are excellent necropsy training DVDs available from a range of other sources; however, there are special conditions operating on cattle ships such as heat, humidity, dirty,

confined pen conditions and limitations on number and type of samples that can be collected and stored.

The special conditions operating on export vessels means that development of a dedicated training DVD specifically for necropsy of cattle during export voyages would be the most effective way to provide suitable information for this industry.

2.4.3 Accredited Stockman Training Course

The current stockman training course is an amalgamation of the original cattle stockman and sheep stockman modules. It is a 5-day fulltime course that covers both the theoretical aspects of livestock husbandry and practical animal handling. The course focuses primarily on the time aboard the vessel, though it does consider some pre-voyage preparation and discharge of the ships at their destination.

The course is run by LiveCorp and involves 3 days of class room training in lecture and workshop format, practical cattle and sheep handling (1 day) and a test (focusing on feed and water provision). About 10% of training time is devoted to health problems of cattle and sheep, environmental observations and postmortem examinations. A necropsy demonstration which was part of the initial training courses has been abandoned in recent years because of logistical and ethical issues and replaced by viewing of the necropsy training DVD described above.

Stockpersons become accredited by attending the training course and participating satisfactorily on two voyages. The courses are held in various locations around Australia according to demand by exporters. Sometimes veterinarians have attended this training although it is not advertised to veterinarians.

2.4.4 The Stockman's Handbook Transport of Cattle by Sea

This LiveCorp publication written by Dr Ross Ainsworth, is used as a training manual during the stockman training and as an ongoing practical reference for accredited stockpersons and veterinarians. It covers all aspects of the live export process that are relevant to stockpersons and devotes relatively large sections to giving good practical information on common health problems, how to detect them and their predisposing environmental and management factors.

The Stockman's Handbook Transport of Cattle by Sea can be access on the FAO website.[7]

2.5 Best Practice Use of Veterinary Drugs Manual

This joint MLA and LiveCorp publication[8] is directed at exporters, managers of livestock assembly depots and stockpersons and provides comprehensive coverage of best practice drug use including the indications for use of different drugs and record keeping. The recommendations on the appropriate use of drugs for certain diseases and conditions and the keeping of treatment records can be the basis for provision of drug usage/treatment data useful for monitoring levels of different disease syndromes occurring at sea.

[7] http://www.fao.org/fileadmin/user_upload/animalwelfare/CattleHandbookApril%202008.pdf
[8] https://www.livecorp.com.au/publications

2.5.1 Is it fit to Export? - Guide

The 'Is it fit to export?' guide[9] is a concise pocket guide designed to assist in the selection of animals for export. The guide is written in simple language using photographs and diagrams, taking into account the current Australian Standards for the export of livestock and relevant sections of the LiveCorp Operational and Governance manual.

2.5.2 Other relevant publications

In the period since this report was prepared a range of additional guides and resource materials on animal handling, transport and welfare related issues have been produced by Livecorp and are available via the Livecorp website[10].

2.6 Constraints to training

The following constraints should be considered in the design of training program:

- Getting veterinarians together in one place at one time for face to face training, especially the small number of in-demand active accredited veterinarians, is difficult.
- Mandated further training for veterinarians may be resisted unless there were incentives or rewards either financial or professional.
- The design of a training program needs to take into account the turnover of active accredited veterinarians (and stockpersons) and the large proportion of inactive accredited veterinarians. With active accredited veterinarians (and stockpersons) being only a relatively small proportion of the total number accredited, an applicant screening process is necessary to ensure that training is not wasted on persons unlikely to utilise it.
- Self-directed training using on-line or workbook packages to achieve even further levels of accreditation would be resisted. Nor are they likely to result in effective or efficient transfer of information given the nature of the skills and knowledge required to be transferred.
- Any notion of having to pay for further training would be strongly resisted. They would probably regard disease investigation training as "nice to have but not essential" refresher training.
- Accredited veterinarians would be resentful and reluctant to participate in a training course on disease investigation if there was any implication that they were not already sufficiently skilled, knowledgeable or experienced. Any training course for veterinarians would be best pitched as a skills-update, refresher type or advanced training.

2.7 Training options

In the light of the above information, it is recommended that the following training options be considered.

2.7.1 Face to face training workshops

A training program **targeting the relatively small number of active accredited veterinarians** and **head stockpersons** could be developed where they attend a two to three day training workshop specifically dedicated to servicing research and disease data collection voyages.

[9] https://www.livecorp.com.au/publications
[10] https://www.livecorp.com.a

Two or three such courses may be required as not all active accredited veterinarians and head stockpersons will be available at the one time.

The courses could be delivered through an agricultural college or university veterinary school.

Continuing professional education points might be awarded to veterinarians as an incentive to participate.

Gribbles Veterinary Pathology have run excellent disease investigation training courses for government and private veterinarians that could be adapted to the needs of the live export industry.

2.7.2 Handbook of protocols, tips and tools

A handbook on disease investigation and data collection procedures and protocols is being developed separately for the LIV.0252 project and this handbook should be a valuable training aid and one of a range of training tools for the project. It is intended that this handbook be developed as a broader industry resource and not just for the Liv.0252 project.

2.7.3 Training DVD

A DVD containing narrated movie clips and PowerPoint presentations of procedures and diseases could be produced.

The DVD would serve as refresher training for some and basic training for others and complement the training provided in face to face workshops and the information in reference handbooks.

The DVD could conveniently and strategically be viewed on board ships by stockpersons, veterinarians and crew to develop a shared understanding of standards and procedures.

There is a Brisbane based company specialising in production of training DVDs that might be well suited to produce a training DVD as one of their producers is an ex cattle veterinarian with research, training and project management experience and skills.

There are a number of excellent off-the-shelf videos on cattle necropsy techniques available in Australia and from overseas; however, the special conditions operating on cattle vessels and the necessary protocols warrants the production of a dedicated necropsy and sample collection training video.

2.7.4 Secondment training

Secondment in the form of a shipboard “traineeship” could be served by accredited veterinarians or stockpersons where they would assist another accredited veterinarian or stockperson. This would best be limited to veterinarians and stockpersons who have completed disease investigation training and are experienced in servicing the project’s (*and ultimately the industry’s*) disease investigation and data collection protocols.

Secondment training would also serve the mentoring needs of accredited veterinarians on their first few voyages to learn how to win over and influence the stockpersons and crew.

As natural attrition depletes the number of accredited veterinarians and head stockpersons, individual new comers could be trained by secondment, referring to the training DVD and handbooks, and participating in the internet forum (see below) until such time that running a face to face “*refresher*” training course was warranted.

2.7.5 Web-based resources

An ***internet forum*** for accredited veterinarians and stockpersons to share their knowledge. This could also serve as a repository for training materials, protocols and reports and a form of mentoring or connection with others who can become mentors.

A variety of resources and training materials could be developed and made available through password protected web sites either in association with LiveCorp or through other web sites. Resources could include downloadable files or manuals/handbooks, video, audio, PowerPoint files, images and other materials.

2.7.6 Broadening training

There are benefits in making elements of stockman training available to veterinarians and conversely in making elements of veterinary training available to stockpersons.

Many veterinarians may benefit from completing the Accredited Stockman Training Courses as a source of excellent training on animal handling and on practical management of animals at sea. It is suggested that consideration be given to making the stockman training available to veterinarians who may wish to participate voluntarily.

In a similar vein, there are aspects of the veterinary training that would be of benefit to stockpersons, recognising that there may be specific requirements including regulatory requirements that may be limited to veterinary surgeons by legislation.

However, there are benefits in making general training provided to veterinarians available to senior stockpersons in particular. This is because under current export regulations, an AAV does not accompany every single voyage – many short haul voyage sin particular do not have an on board AAV. In addition even on voyages where there is an AAV, a senior stockperson may be able to provide considerable assistance in routine observations of animals and even in performing necropsy examinations under AAV supervision.

3 Appendix 3: Veterinary Export Handbook (W.LIV.0252)

3.1 Introduction

The Veterinary Export Handbook (W.LIV.0252) was intended to deliver against Objective 1 and Objectives 2 and 3.

The first printed version was released in 2010 and it was then revised several times to incorporate feedback from AAVs and exporters after piloting and in response to industry consultation over procedures.

The final version (Version 16) was dated 31 October 2011 and is reproduced on the following pages of this appendix. Please note that printed copies of the Veterinary Export Handbook (W.LIV.0252) were prepared in A5 format and printed on reinforced, water-proof paper with ring binding to allow ease of carriage and use on board export ships.

The reproduction on the following pages has the content from the final version but has been re-sized into A4 format. Note that the Veterinary Export Handbook (W.LIV.0252) is presented as a stand-alone section with its own table of contents and with page numbering set to start at page 1.

The Veterinary Export Handbook (W.LIV.0252) was specifically written to provide a resource to guide AAV (and stockperson) activities undertaken as part of the research project W.LIV.0252. Activities such as completing sick and dead cattle forms and collecting biological samples (swabs and tissue samples in preservative) from necropsy examinations were part of the research activities associated with W.LIV.0252. It was not intended that these research activities would persist beyond the scope of the research project. Much of the more generic content of the Veterinary Export Handbook (W.LIV.0252) was seen as being relevant beyond the W.LIV.0252 project. Our approach to this was to plan the production of a separate booklet/handbook that would be designed to act as a general resource for routine voyages and that would not contain any specific requirements for completion of data collection forms or collection of biological samples from necropsy examinations. This separate handbook was completed as the *Veterinary Handbook for the Live Export Industry.*

Veterinary Export Handbook

Disease investigation guidelines for veterinarians and stockpersons on long sea voyages carrying cattle

Version 16

31 October 2011

Table of Contents

Preface

Funding for this handbook was provided by Meat and Livestock Australia and LiveCorp.

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A large number of people have made significant contributions to the writing or editing of this handbook. Tristan Jubb was responsible for the initial drafting of much of the content. In alphabetic order of surnames, the following people are gratefully acknowledged for their contributions to writing, editing or formatting the handbook: David Beatty, John Creeper, John House, Geoff Manefield, Michael McCarthy, Jo Moore, Greg Norman, Mandy O'Hara, Nigel Perkins, Barry Richards, Lynn Simpson, Robyn Tynan.

1 Introduction

This handbook was produced to assist veterinarians and stockpersons achieve best practice and a consistent approach to investigating disease events, collecting disease data, and preventing and treating disease in cattle on long sea voyages. It contains:

- terminology and descriptions for common syndromes, diseases and conditions causing sickness and death in live export cattle
- procedures for investigating disease events including collecting samples and identifying predisposing factors.
- templates for standardised data collection to assist compilation of voyage reports.

It complements the existing *Stockman's Handbook - Transport of Cattle by Sea*[11] as part of the live export industry's efforts to achieve better health and welfare outcomes for exported animals.

A glossary of scientific terms is located at the end of this manual.

2 Common syndromes and diseases in shipboard cattle: diagnosis and treatment

This section lists the common syndromes affecting ship-board cattle, the diseases responsible, and advice on diagnosis and treatment.

The treatments suggested have been made with regard to the facilities, equipment, medications and time that are available on board most cattle ships.

[11] Stockman's handbook – transport of cattle by sea, short and long haul voyages. Ross Ainsworth. LiveCorp. April 2008

Table 2.1: Clinical syndromes encountered on cattle ships and the diseases and conditions that may cause them

Syndrome	Differential diagnoses
1. Nasal discharge	• Infectious bovine rhinotracheitis • *Mycoplasma bovis* – upper respiratory tract infection as part of clinical complex • Irritation of nasal mucosa from dusty feed • Inappetence such as from indigestion with failure to lick nose • Pneumonia • Reflux associated with oesophageal or gastrointestinal obstruction
2. Respiratory distress	• Pneumonia/pleurisy • Heat stress • Bloat causing compression of diaphragm • Physical exertion • Anoxia from exhaust gases, or exposure to toxins in feed (nitrate/nitrite, cyanide)
3. Lameness	• Solar abscesses, bruised soles and decubitus ulcers from excessive wear on abrasive flooring • Foot rot • *Mycoplasma bovis* – joint swelling and lameness are part of complex • Traumatic injuries, often from slipping or being ridden, causing fractures, dislocations, bruising, wounds
4. Diarrhoea	• Indigestion • Rumen acidosis • Salmonellosis • Bovine Viral Diarrhoea Virus (BVDV)
5. Watery eyes	• Pinkeye • Infectious bovine rhinotracheitis • Foreign bodies especially grass seeds, chaff or dust from feed entering eye/s
6. Alopecic skin lesions	• Ringworm • Stephanofilariasis a skin worm transmitted by buffalo fly bites • Dermatophilosis • Herpes virus (pseudolumpy skin disease) • Faecal scalding
7. Ill-thrift	• Shy feeder • Persistent infection with pestivirus • Chronic infection such as pneumonia, pleurisy, fungal rumenitis, liver abscesses

Table continued next page

Table 2.1 continued

Syndrome	Differential diagnoses
8. Distended abdomen	• Frothy bloat • Gas cap bloat • Advanced pregnancy • Vagal indigestion • Oesphageal obstruction with a fruit, vegetable or milled feed • Ruptured urethra in steers • Gastrointestinal accident/obstruction such as displaced or torsed abomasum
9. Knuckling	• Lumbar spinal injury from being ridden • Ruptured gastrocnemius tendon • Damage to lower limb nerve (peroneal n) from prolonged recumbency on hard and or uneven surface
10. Nervous disease	• Hypocalcaemia or hypomagnesaemia • Meningitis as extension of bacterial pneumonia i.e. thromboembolic meningoencephalitis (TEME) • Tick fever especially *Babesia bovis* • Grain poisoning can cause staggering and blindness • Poisoning with lubricants, fumigants or exhaust gases • Polioencephalomalacia from dietary changes
11. Prolonged recumbency	• Musculoskeletal injuries • Footrot or sepsis in multiple feet • Ephemeral fever • Exhaustion/advanced disease
12. Straining	• Prolapse of vagina or rectum from: advanced pregnancy, over-fatness, persistent coughing • Rectal mucosal irritation from chronic diarrhoea causing straining • Urinary tract obstruction

2.1 Nasal discharge

Nasal discharge is any excess of fluid material from the nasal cavity. The connection of the upper respiratory and alimentary tracts means that discharges can originate from either tract, however, excessive or abnormal discharge is usually an indication of upper respiratory tract disease. Discharges may be serous (thin, clear and colourless), catarrhal (grey, flocculent) purulent (thick, yellow), or haemorrhagic (red) and progress through these appearances depending on the progress of mucosal damage. Colour, consistency and content will often reveal the source. Presence of food or stomach content indicates obstruction of the oesophagus or gastrointestinal tract, respectively – generally accompanied by distress and severe systemic signs. Unilateral discharges indicate local infection; bilateral discharges usually indicate systemic infection. Healthy cattle normally remove most nasal discharge with their tongue.

Pneumonia does not necessarily cause bilateral nasal discharge; pus and mucus, that is coughed or moved upward by mucociliary action from the lung is mostly swallowed.

The most likely differential diagnoses in shipboard cattle with nasal discharge include:

- infectious bovine rhinotracheitis (IBR)
- dusty feed causing irritation of nasal mucosa
- other respiratory pathogens - a range of pathogens, mainly viral, with upper respiratory tract infection as part of clinical complex – bovine adenovirus, respiratory syncitial virus, bovine virus diarrhoea virus, *Mycoplasma bovis* and *Histophilus somni*
- pneumonia
- reduced grooming of the nose with the tongue occurs with sick cattle
- oesophageal or gastrointestinal obstruction may cause reflux to appear at the nares

2.1.1 Infectious bovine rhinotracheitis (IBR)

Infectious bovine rhinotracheitis is an upper respiratory tract viral infection manifesting as fever, coughing, nasal and lachrymal discharges and salivation. In uncomplicated infections, lesions are confined to the upper respiratory tract and trachea and recovery occurs within a week. Infectious bovine rhinotracheitis infections can spread through the crowded population of cattle on a ship in a matter of days. Secondary bacterial pneumonia may follow in cattle that are severely affected or have additional stressors such as simultaneous hot and humid conditions. Treat severe cases with antibiotics to prevent development of secondary bacterial pneumonias. Vaccines are available to assist prevention.

2.1.2 Dusty feed

Dusty feed will cause nasal discharge and coughing but animals will be bright and alert, appetent and afebrile. Examination of the feed will assist diagnosis. The problem may be related to a batch of feed which when changed, resolves the problem. No treatment or action is required unless signs become severe, in which case a respiratory pathogen should be suspected. Dampening the feed may help but may result in mouldiness and palatability problems.

2.1.3 Other respiratory pathogens

There are a range of pathogens, mainly viral, that can cause upper respiratory tract infections and nasal discharge. They include bovine adenovirus, bovine respiratory syncitial virus, bovine virus diarrhoea virus (BVDV), bovine herpesvirus-1, bovine reovirus, enterovirus, coronavirus and rhinovirus. These viruses can serve as initiators of bacterial pneumonia in stressed cattle. Two bacterial pathogens, *Mycoplasma bovis* and *Histophilus somni* may cause nasal discharge, but this would be as part of a more general disease. Vaccines are not available for prevention of most of these respiratory diseases. BVDV is discussed further under Diarrhoea, *Mycoplasma bovis* under Lameness and *Histophilus somni* under Nervous signs as these three pathogens target other organs more prominently.

2.1.4 Pneumonia

Cattle with viral or bacterial pneumonia will have fever, cough, and varying respiratory impairment. Nasal discharge may be present in some animals. Most tracheobronchial exudate that reaches the pharynx will be swallowed. Pneumonia is discussed further under Respiratory distress.

2.1.5 Reduced grooming of the nose with the tongue

Reduced grooming of the nose and resulting accumulation of nasal secretions in the nares occurs in sick cattle. It may be an early sign of systemic disease.

2.1.6 Oesophageal and gastrointestinal obstruction

Oesophageal and gastrointestinal obstruction are discussed under the syndrome *Abdominal distension* below*.*

2.2 Respiratory distress (dyspnoea)

Dyspnoea occurs when breathing is affected by physical, physiological or environmental factors, either alone or in various combinations. Dyspnoea is most often associated with disease of the respiratory tract such as airway obstruction, pneumonia, tracheitis, bronchitis, or alveolitis. Pulmonary congestion, pleural effusions, hypoxaemia, neuromuscular dysfunction and abdominal distension/thoracic compression may also cause dyspnoea. Exertion will cause temporary dyspnoea. Heat stress is a common cause of dyspnoea in breeds not tropically adapted.

Dyspnoea accompanied by coughing is indicative of tracheobronchial disease.

The most likely differential diagnoses in shipboard cattle with respiratory distress include:

- pneumonia
- heat stress
- bloat causing compression of diaphragm
- physical exertion
- hypoxia from engine exhaust gases, or exposure to toxins in feed (nitrate/nitrite, cyanide)

2.2.1 Pneumonia

Pneumonia is a common and serious disease in long voyages where there are combinations of crowding, heat or cold stress and inadequate ventilation. The extent of disease is usually only fully appreciated when deaths occur or lungs of slaughtered animals are examined at destination. A number of viral, bacterial and mycoplasmal pathogens may act individually or combine to cause disease. In feedlots, the recognised pathogens are bovine herpesvirus 1, bovine respiratory syncytial virus, bovine coronavirus, bovine viral diarrhea virus, *Mannheimia haemolytica*, *Pasteurella multocida*, *Histophilus somni*, *Arcanobacterium pyogenes*, *Salmonella* spp., and *Mycoplasma* spp. – the same situation likely applies in shipboard cattle.

Stress with or without viral infections suppresses host defenses allowing proliferation of commensal bacteria in the upper respiratory tract and subsequent extension to the lower respiratory tract to cause pneumonia which can extend to pleurisy.

Fever, inappetance and depression in the absence of obvious respiratory signs may be indications of early to advanced pneumonia. Nasal discharge may be present. The earliest cases of heat stress may be animals with pneumonia. Cattle with pneumonia deteriorate very quickly in hot humid conditions as normally functioning lungs are an important means of shedding heat load.

Misdiagnosis of presence or absence of pneumonia based on auscultation and percussion of the thorax is notoriously common. Unlike normal cattle, close observation will usually detect

a distinct breathing effort that may be fast or slow, but usually shallow because of pleuritic pain. Treat suspected cases with antibiotics, isolate in a well ventilated area if practicable and maintain hydration. Low stocking rates, good ventilation and vaccination against respiratory pathogens can markedly reduce morbidity and mortality from pneumonia.

2.2.2 Heat stress

British and European (*Bos taurus*) breeds are affected by heat stress when entering the high temperatures and humidity of the equatorial band. Tropical breeds (*Bos indicus*) and their crosses remain largely unaffected. Unacclimatised *Bos taurus* cattle, particularly if fat, have long hair coats, are in crowded pens and have difficulty accessing water, can die within hours of onset of hyperthermia. Heat stress is probably one of the main predisposing factors for pneumonia. Rectal temperatures may reach 43.0^{o}C

2.2.3 Bloat

Bloat causes respiratory distress by the tightly distended rumen compressing the thoracic cavity. Bloat is discussed further under the syndrome of Abdominal distension.

2.2.4 Physical exertion

Physical exertion will cause temporary respiratory distress.

2.2.5 Hypoxia from engine exhaust gases

Carbon monoxide and carbon dioxide poisoning may occur in poorly ventilated pen areas where portable combustion engines are being used for repairs or maintenance.

2.2.6 Hypoxia from exposure to toxins in feed

Shipboard cattle are normally fed hay, chaff or pellets which carries very low risk of nitrate-nitrite or cyanide poisoning compared to the silage and green chop from certain pastures and crops. Nitrate- nitrite poisoning may occur if feeding hay made from plants that have been fertilised with nitrogen, cut when stressed by heat or dampness, or improperly cured. Hay made from wilted forage sorghum and fed to hungry cattle may cause cyanide poisoning. There will be weakness and ataxia, brown cyanotic mucous membranes with nitrite poisoning, cherry red mucous membranes with cyanide poisoning, before collapse and death in asphyxial convulsions. Treat cyanide poisoning with intravenous sodium nitrite and or sodium thiosulphate if available.

2.3 Lameness

Lameness due to pain in the limbs or trunk must be differentiated from ataxia that is the result of peripheral or central nervous system disease or muscular weakness from an abnormal systemic state. Lameness can be difficult to detect in crowded pen conditions. It is easier to diagnose when there are swellings, abrasions and non-weight bearing in single limbs, however, lameness in multiple limbs can be obscure. Design and floor management of pens greatly influence the number and severity of lameness cases.

Injuries and infections can be sustained before the voyage, during transport and loading, and during the voyage – all must be treated early and intensively. Even a minor problem can quickly become life-threatening if it causes the animal to become a ‘downer’.

Most lameness in live-export cattle, involves the foot especially the lateral claws of the hind limbs because they are subjected to the most wear from twisting and turning. Lame cattle can be identified by swellings, non-weight-bearing limbs, reluctance to move or prolonged recumbency. Inspect the limbs of recumbent cattle carefully as it is not uncommon for penned cattle to become lame in multiple limbs simultaneously causing them to lie down. A tail with a depleted brush may indicate that the animal has been down excessively with its tail being trodden on. Decubitus ulcers on fetlock, hock and knee joints occur in animals that are lying down for prolonged periods as a result of lameness or other condition and are an ominous sign. Much lameness can be prevented by quiet handling of livestock and matching pen mates on sex and size.

The most likely causes of lameness in shipboard cattle include:

- solar abscesses, bruised soles and decubitus ulcers from excessive wear on abrasive flooring
- Foot rot
- traumatic injuries, often from slipping, trampling or being mounted, causing fractures, dislocations, bruising, wounds
- *Mycoplasma bovis*, *Histophilus somni* and Chlamydiosis– joint swelling and lameness are part of complex

2.3.1 Solar abscesses, bruised soles and puncture wounds

Solar abscesses, bruised soles and puncture wounds of the sole are associated with excessive wear of moisture-softened feet on rough or abrasive flooring. Cattle that obsessively mount other cattle wear away the front part of the hind claws becoming severely lame from bruising and infection. All should be treated early and aggressively to prevent infection extending up the leg and to prevent the animal going down. Treat solar abscesses and puncture wounds by paring sole and wall around the injury to establish drainage, and administering antibiotics and anti-inflammatory drugs. If facilities, equipment and expertise are available, elevating the inflamed claw by applying a lift to the healthy claw in the form a plastic shoe or a wooden or plastic block glued to the sole will provide dramatic pain relief and help keep the animal on its feet and alive. Such shoes and blocks are commercially available. Isolate to provide comfort, ready access to feed and water and ease of monitoring and further treatment. Soften the floor with sawdust or straw.

2.3.2 Footrot

Footrot is not uncommon in the constantly wet, macerating pen conditions. The bacterial cellulitis affecting the interdigital cleft is extremely painful, pushes the claws apart and the foot will be swollen – usually only one foot is infected. Treat with parenteral antibiotics – recovery usually begins in a few hours and is completed in one to two days so affected animals generally do not require isolation. If lameness does not resolve in a few days check for a solar abscess.

2.3.3 Traumatic injuries

Traumatic injuries caused by slipping or being mounted include fractures, dislocations, bruising and wounds. Dislocated joints require early intervention and expertise for successful reduction. Fractures demand euthanasia. Treat superficial wounds with a topical spray or lotion. ***Haematomas*** occur on points of hips following forceful contact with corner posts

during transport and loading. They are unlikely to cause lameness but are unsightly. No treatment is required - draining blood from these can delay and complicate healing and is best avoided.

2.3.4 Mycoplasma bovis, Histophilus somni, Chlamydophila spp

These pathogens may infect ship board cattle. They may cause respiratory disease and arthritis and with *Mycoplasma bovis*, also mastitis. Lameness and joint swelling from arthritis may be the dominant manifestation. Early and prolonged treatment with long acting oxytetracycline is recommended.

2.4 Diarrhoea

Diarrhoea is the passage of faeces with high water content. It may be accompanied by blood as dysentery, fresh blood as in haemorrhage, clotted or digested as in melaena or by fibrin coagulated in clots or plaques. Diarrhoea may be osmotic if osmotically active nutrient enters the intestine, as happens with nutrient overload. It may be secretory if endotoxin injury causes the small intestine to secrete electrolytes and fluid, as happens in enterobacterial infections. It may be malabsorptive if the effective absorptive epithelium of the ileum and colon is reduced by atrophy or erosion.

The most likely causes of diarrhoea in shipboard cattle include:

- indigestion associated with dietary changes
- salmonellosis
- rumen acidosis
- bovine virus diarrhoea virus infection

2.4.1 Indigestion associated with dietary changes

Indigestion is the most common cause of diarrhoea in shipboard cattle, usually associated with the feeding of a new batch of pellets. Cattle have watery faeces but otherwise appear healthy with normal or slightly depressed appetite. Multiple animals in multiple pens will be affected. The diarrhoea usually resolves in a few to several days as rumen flora adapt. Substituting chaff or hay for part of the pellet ration speeds recovery. Prevent by adapting cattle to the shipboard ration before the voyage.

2.4.2 Rumen acidosis

In live export cattle, rumen acidosis usually follows excessive consumption of pellets containing high concentrations of grain. High levels of lactic acid form in the rumen that kill essential gut microflora, damage the mucosal lining, and draw in body fluid. This leads to rumen stasis and dehydration. Usually only mild forms occur with watery faeces accompanied by temporary inappetance. In severe cases there will also be dehydration, weakness and depression with some animals dying. The only practical treatment on ship is to replace pellets with hay or chaff and maintain adequate fluid intake. Bicarbonate infusions into the rumen might be considered in early cases.

2.4.3 Salmonellosis

Individual cattle but sometimes multiples, suffering fever, depression, dehydration and putrid diarrhoea or dysentery will probably have salmonellosis. Some cattle die in one or two days, others with moderate intestinal injury may have a protracted course before recovery or

death. Prompt treatment with antibiotics and maintaining adequate hydration are important for full recovery. Isolate if practical and implement hygiene to prevent spread to other cattle and humans.

2.4.4 Bovine viral diarrhoea virus infection (BVD)

BVD infection is usually a mild infection of young cattle. Virulent strains cause high fever, nasal discharge, lacrimation, oral ulcerations, diarrhoea, eruptive lesions of the coronary band and interdigital cleft and sometimes haemorrhaging. High morbidity and moderate mortalities may result. BVD infection of pregnant cows may result in abortion, delivery or normal and immune calves, and in some cases birth of persistently infected (PI) animals that may show no signs of illness and yet are capable of being life lone shedders of the virus. PI animals usually become illthrifty and die before two years of age.

Malignant catarrhal fever can resemble BVDV because of oral and muzzle erosions but cases are usually older, are in single animals and have bilateral corneal opacity. The muzzle and oral erosions of bovine papular stomatitis can look similar but diarrhoea is not a feature unless they have intercurrent ostertagiasis.

If active BVD infection is suspected in cattle, provide nursing and treat severely affected cattle with antibiotics to prevent pneumonia.

Control programs generally involve testing to detect and cull PI animals and vaccination.

2.5 Eye discharge (Watery eyes)

Eye discharges are serous with blockage of the tear duct and in the early stages of inflammation, becoming purulent in the later stages. Unilateral discharge may be due to local inflammation, bilateral discharge may be due to systemic disease. Eye discharge associated with closed, partly closed or excessive movement of eyelids indicates pain in the eye. Injury or infection involving the cornea and conjunctiva may result in vascularisation, corneal ulceration and scarring.

The likely causes of eye discharge in shipboard cattle include:

- infectious bovine rhinotracheitis,
- pinkeye and
- foreign bodies.

Excessive lacrimation may accompany many other systemic diseases including heat stress, bovine viral diarrhoea virus infection, ephemeral fever and malignant catarrhal fever for which other signs and circumstances will be diagnostic.

2.5.1 Pinkeye

Pink eye is an infectious bacterial keratoconjunctivitis caused by *Moraxella bovis* that affects British and European cattle breeds more severely than tropically adapted breeds. It may occur in individual cases or as an outbreak depending on immunity developed from previous exposure or vaccination. Predisposing factors are those that spread the bacteria and injure the eye. These include dusty feed, chaff, grass seeds, flies, pens in areas of fast airflows and high pressure cleaning of decks covered with sawdust. Excessive lacrimation is an early sign. Later signs may include ulceration of the cornea, perforation of the cornea, and white-yellow discolouration of the eyeball. There is an array of topical treatments available,

however, the most practical treatment for penned cattle is early treatment with a long acting intramuscular antibiotic. Prevention is by minimising the above mentioned risk factors.

2.5.2 Infectious bovine rhinotracheitis

Infectious bovine rhinotracheitis (IBR) is discussed under the syndrome *Nasal discharge*. Eye discharge may be one of the earliest signs of IBR with nasal discharge and coughing becoming more prominent in later stages.

2.5.3 Ocular foreign bodies

Ocular foreign bodies, especially grass seeds or chaff, may have entered the eye from feed. Examination of the upper and lower conjunctival recesses, after applying good physical restraint aided by sedation and, if available, suitable topical anaesthetic, enables removal of foreign bodies with tweezers. Topical antibiotics in the form of spray or ointment can be applied to the eye, however, parenteral administration of long acting antibiotics is likely to be more effective and longer lasting.

2.6 Alopecia

Alopecia refers to loss of hair from the skin. Alopecia will most likely be a primary problem rather than secondary to a systemic problem. Its main impact is not on health but on the aesthetic appearance of the cattle, and its effect on hide value and acceptability at destination. Differentiating alopecic lesions as to whether they are discrete or diffuse, limited or extensive and whether they are accompanied by changes in colour and conformation of the underlying skin will give clues as to the cause.

Alopecia in shipboard cattle is likely to be caused by:

- ringworm
- urine and faecal scalding
- stephanofilariasis
- dermatophilosis
- pseudolumpy skin disease

2.6.1 Ringworm

Rubbing against fomites and other infected animals causes these lesions mainly to affect the head and neck. Outbreaks are difficult to stop and time for hair to regrow can be long treatment. Early detection followed by isolation, disinfection of facilities and treatment are required to minimise impact. Treat with imidazole spray. Expect severely affected cattle to be rejected at some destinations.

2.6.2 Urine and faecal scalding

Continual wetting, maceration and excoriation of the skin of the lower legs and flanks continually coated by urine and faeces may cause patchy alopecia in these areas in individual or groups of animals. Animals that spend a lot of time lying down are most susceptible. The condition may be associated with *Dermatophilus congolensis* infection in which case treatment with antibiotics may be warranted. No treatment is available for urine and faecal scalding other than ensuring animals are in clean and dry pen conditions.

2.6.3 Stephanofilariasis

Stephanofilarial lesions are the scars resulting from a skin worm transmitted by buffalo fly bites. These dry flaky discrete lesions occur around the eyes and ventral neck but may extend over the lateral neck, thoracic and abdominal skin. They will have been acquired in the weeks or months before loading. On board treatment is usually impractical. Treatment with macrocytic lactones may cause some resolution over weeks or months but some scars may be permanent.

2.6.4 Dermatophilosis

Prolonged wetting, high humidity and temperature predispose to this bacterial exudative dermatitis with scab formation. Extensive matting of hair occurs. Alopecia develops if the scabs are pulled or rubbed off. In live export cattle alopecic lesions affecting the skin of the lower legs and flanks, the areas which are continually wet when standing or lying down, may be due to dermatophilosis or faecal and urine scalding and excoriation. Treat severe cases with antibiotics but expect recurrence if wet, humid conditions persist.

2.6.5 Herpes virus (pseudolumpy skin disease)

This is a mild systemic viral skin disease affecting cattle in the tropics. Lesions are circular areas of alopecia distributed over the head, neck, shoulders and back up to 2 cm in diameter resembling ringworm or stephanofilariasis. No treatment is necessary. Healing occurs in a few weeks.

2.7 Illthrift (wasting)

Illthrift is the loss of body condition in the presence of ample feed. It is most noticeable by the reduction in size of the abdomen (i.e. they will have *hollow flanks* and a *tucked up* posture) and muscles of the back and rump regions relative to skeletal dimensions. Change in body condition score over time may provide an indication of loss in condition. Different hair length, lustre, density and colour may stand out. Cattle may appear healthy and bright, perhaps overly bright.

Illthrift may have a variety of difficult-to-detect underlying causes including parasitism, infectious diseases, chronic conditions causing organ dysfunction or toxaemia, specific nutrient deficiencies such as copper, and conditions causing pain. Also, underlying disorders may include indigestion, mild rumen acidosis, abomasal ulcer, pneumonia, liver abscess, local peritonitis and mild laminitis in all four feet. Single or multiple animals may be affected. With shipboard conditions, some cattle will simply be shy feeders that are having greater difficulty than pen mates in adapting to the unfamiliar environment, the type of feed and water and the way it is offered.

The most likely causes of illthrift in shipboard cattle include:

- shy feeders
- persistent infection with pestivirus
- chronic toxemia or pain associated with conditions such as pneumonia, pleurisy, rumenitis, liver abscessation and abomasal ulceration

2.7.1 Shy feeders

The term shy feeder is used to refer to animals that are not eating as well as expected. Greater susceptibility to stress is assumed to be the reason why some individual shy feeders

occur in a group of cattle. Treatment options include adding hay or chaff to the pellet ration, a change of pen or pen mates, and antibiotics and anti-inflammatory drugs if underlying disease is suspected or other efforts are ineffective. If illthrift is becoming widespread, check the quality of water, especially for rust, and the quality of feed, especially for fuel, lubricant, fumigant or mould contamination.

2.7.2 Pestivirus (see Bovine viral diarrhea virus – 2.4.4)

Consider persistent infection with pestivirus in individual illthrifty cattle that have not undergone preshipment screening.

2.7.3 Chronic toxaemia or pain

Treat with antibiotics and anti-inflammatory drugs depending on the underlying condition that is suspected and monitor closely the response. It is possible that long and costly courses of treatment may be required to achieve improvement, and relapse may occur upon withdrawal of treatment.

2.8 Distended abdomen

Abdominal distension when viewed from the front or rear of the animal may be unilateral, bilaterally symmetrical, asymmetrical or more prominent in the dorsal or ventral half depending on cause.

Passing a stomach tube, auscultation with percussion and ballottement to detect areas of gas and fluid, insertion of a trochar and examination of faeces may assist in deciding cause and level of urgency to intervene.

Of the many causes of abdominal distension, those that should be given greater consideration in shipboard cattle include:

- frothy bloat
- free gas bloat
- advanced pregnancy
- vagal indigestion
- oesophageal obstruction with a fruit, vegetable or milled feed
- ruptured urethra in steers
- gastrointestinal accident/obstruction such as displaced abomasum or a bezoar (phytobezoar or trichobezoar)

2.8.1 Frothy bloat

Feeding fine or dusty feeds may cause bloat in multiple cattle. A stable foam, difficult to eructate, forms in the rumen. Compression of the thorax causes respiratory distress and asphyxiation if severe. The problem, if mild, is treated by adding chaff or hay to the feed or painting bloat oil on the flank which is licked off by the patient.

The problem if more than mild will need to be treated with products that break down the foam by modifying surface tension. The resulting free gas layer is more readily eructated. Specific products for oral or intrarumenal (via a cannula or large bore needle) administration are available.

Life threatening distension is treated by venting the rumen through a small hole in the left flank made with a knife or trochar and cannula.

2.8.2 Free gas bloat

Inflammation (such as from warts or penetrating wire) or a foreign body (such as plastic or string) in the area around the oesophageal groove can interfere with eructation and cause free gas bloat. Usually only individuals are affected. Resolution may require antibiotics, or surgery to create a rumen fistula, or the passage of time, or all three. Consider inserting a commercially available plastic, self-retaining cannula. The accompanying trochar is not usually robust enough to penetrate the skin so it is best to make an incision with a scalpel at the intended place of cannula insertion.

Make a vertical incision through skin and underlying fascia of a length equal to twice the diameter of the cannula body. With the trochar in place in the lumen of the cannula, sharply thrust through the abdominal and rumen walls. With the trochar still firmly in place, screw the cannula in so that the spiral flange holds the rumen firmly against the abdominal wall. The trochar is then removed and the gas allowed to escape. Gas escape is best controlled in order to avoid a sudden fall in blood pressure that accompanies the sudden fall in intra-abdominal pressure. The cannula can remain in place for as long as necessary, which may be as long as two weeks.

A stomach tube passed down the oesophagus into the rumen can be used to relieve free gas bloat. However, severely distended cattle have been known to drop dead when this has been done.

2.8.3 Advanced pregnancy

Pregnancy of six months or more may be detected by ballottement through the right abdominal wall.

2.8.4 Oesophageal obstruction

Oesophageal obstruction may occur from feed impaction but also if a fruit or vegetable of critical size has found its way into a feed trough. Dehydration, poor feed quality and problems with chewing (teeth or tongue injury) may predispose. Bloat and profuse salivation will usually be observed. Treatment options include sedation with xylazine to relax the oesophagus that might be in spasm and gentle passage of a stomach tube to try to force the obstructing mass into the rumen.

An obstructing mass can sometimes be quickly and easily removed from the proximal oesophagus by an experienced operator reaching down the throat. Alternatively, an obstruction in the cervical oesophagus may be able to be massaged up to and into the pharynx by pressing the fingers into each side of the ventral neck behind the mass. When at the level of the pharynx, keep the fingers pressed into the oesophagus until the animal ejects the mass.

If the mass is in the lower cervical or thoracic oesophagus, a carefully manipulated loop of wire passed down the oesophagus by an experienced operator may be worth a try.

2.8.5 Gastrointestinal obstruction

Gastrointestinal obstruction can have many causes including foreign bodies, intussusceptions, volvuli and displacements affecting the abomasum and small and large intestines. Dislodgement of benign abomasal bezoars into the intestine associated with

dietary change is usually lethal. Both phytobezoars and trichobezoars may occlude the pylorus or intestine with like result.

Affected cattle may show signs of abdominal pain, be inappetent and pass no faeces, or scant faeces covered in mucus or blood. Rectal examination can be expected to reveal a completely empty rectum with a dry but sticky feel. A ping and sloshing fluid may be detected upon auscultation and ballottement of a distended abdomen. With the exception of left displacement of the abomasum, bold and early surgical intervention and often fluid therapy are required to save the animal. Successful surgery is often performed for LDA, but the need is not so urgent.

If suitable facilities and equipment are not available, and with the possible exception of LDA, prompt euthanasia of the animal should be performed.

2.8.6 Vagal indigestion

Individual cattle may develop disturbances in rumen motility causing indigestion and fluid accumulation in the rumen. The most common cause is thought to be localised peritonitis affecting the vagus nerve as it passes around the reticulum resulting in so-called vagal indigestion. Ballottement will detect a large fluid filled rumen. The most common cause of localised peritonitis will be associated with penetration of the wall of the reticulum with nails, needles or short pieces of wire (so called traumatic reticuloperitonitis). Outbreaks may occur if a length of wire has been milled in the preparation of chaff. Treat with antibiotics and feed hay as a portion of the diet to try to stimulate normal rumination.

2.8.7 Ruptured urethra in steers and bulls

Diets high in grain, calcium or magnesium may cause formation of urethroliths which in steers can block the urethra leading to bladder distension and eventual urethral perforation or bladder rupture. There may be abdominal distension from urine accumulation in the abdominal cavity if the bladder has ruptured, or subcutaneous swelling along the prepuce and ventral abdomen if the urethra has perforated; and rectal prolapse from straining to void urine. Death follows rupture of the bladder. A ruptured urethra may resolve without intervention if tissue sloughs and a patent urethra is established however establishing patency via surgical means increases survival and aesthetic outcome. Options for prevention include adjusting mineral balance in or adding salt to the diet, or both. If one steer is diagnosed with urethral obstruction then all males are at risk.

Bulls may incur rupture of the urethra due to mounting behaviour. The typical subcutaneous swelling due to urine in the tissues is seen. Necrosis of subcutaneous tissues and, if the animal survives for sufficient time, sloughing of the skin occurs. It is then not uncommon for the penis to protrude ventrally through the slough. Simple treatment is a 10cm long deep draining incision, one on each side of and 10 cm from and parallel to the midline. It is desirable that these incisions are kept clean and open to provide adequate drainage for the accumulated urine. The urethra has notable powers of recovery and reestablishment of normal patency is usual.

2.9 Knuckling

Knuckling is the state of flexion of the fetlock joint while the soles of the hooves are bearing weight. In cattle, knuckling is most common in the hind legs and is associated with peroneal, tibial and mild sciatic nerve injury.

The likely causes of knuckling in shipboard cattle are:

- lumbar spinal injury from being mounted
- ruptured gastrocnemius tendon
- damage to lower limb nerve (peroneal n) from prolonged recumbency on hard and or uneven surface

Extreme knuckling, walking on the anterior aspect of the fetlock, may be seen most frequently in the forelimb due to trauma (or rupture) involving the extensor ligament or its associated musculature.

2.9.1 Lumbar spinal injury

Lumbar spinal injury usually occurs from being ridden by other cattle. It usually manifests as bilateral knuckling in single animals. Isolate and treat with drugs that will reduce inflammation. Prevent if practical by isolating cattle that are riding or being ridden excessively and match pen mates by size and sex.

2.9.2 Damage to lower limb nerve (peroneal n)

This follows prolonged recumbency on hard and or uneven surface. Usually manifests as unilateral mild knuckling. The peroneal nerve is bruised at the point where it crosses the lateral stifle. Be aware that an underlying condition may have predisposed to prolonged recumbency. Treat with drugs that reduce inflammation and control any underlying condition.

2.9.3 Ruptured gastrocnemius tendon

This manifests as unilateral (rarely bilateral) severe knuckling with a markedly dropped hock joint that is particularly obvious in the standing animal. This injury usually follows desperate attempts to rise on a slippery floor in an animal already weakened by other disease. These animals cannot walk and have major difficulty rising therefore prompt euthanasia is recommended once the diagnosis is confirmed.

2.10 Central nervous disease

Disease processes affecting the nervous system of ship board cattle will be mainly infectious or inflammatory, toxic, metabolic, traumatic or vascular. There are others such as degenerative, familial and neoplastic but these will be extremely rare. Specific viruses and bacteria will cause the infections. Insecticides, fungicides and rodenticides may cause toxicities. Hypoglycaemia, hypoxia, hepatic dysfunction, hypocalcaemia and hypomagnesaemia can cause metabolic nervous diseases. Haemorrhage, oedema and direct physical damage to the central nervous system can cause a range of focal or multifocal neurological deficits. Septicaemia and bacterial emboli cause vascular lesions in the central nervous system. With inflammatory, metabolic and toxic processes there will be evidence of disease in other body systems. With traumatic and toxic exposures there may

be obvious external signs or clues. Toxic and metabolic processes are unlikely to produce asymmetric deficits.

- hypocalcaemia or hypomagnesaemia
- meningitis as extension of bacterial pneumonia, i.e. thrombotic meningoencephalitis
- tick fever, especially *Babesia bovis*
- grain poisoning can cause staggering and blindness
- poisoning with lubricants, fumigants or exhaust gases
- polioencephalomalacia from dietary changes

2.10.1 Hypocalcaemia and hypomagnesaemia

In shipboard cattle this is most likely to occur in association with sudden climatic or dietary changes or after long periods of food and water deprivation while being transported or held in yards. Hypocalcaemia and hypomagnesaemia usually accompany each other to varying degrees and clinical signs will be related to which is more profound. Rumen acidosis from feeding batches of pellets with higher than normal levels of fermentable carbohydrates is consistently accompanied by hypocalcaemia.

Hypocalcaemic cattle may be seen to be ataxic before becoming recumbent and depressed with a dry nose and reduced rumen movements. Simple hypocalcaemia is diagnosed if treatment with subcutaneous calcium injections leads to an immediate and complete recovery. Hypocalcaemia complicated by indigestion will require other treatments to normalize rumen function such as feeding hay, lowering pH with sodium bicarbonate or administration of rumen fluid from a healthy animal. With hypomagnesaemia, an affected animal usually exhibits hyperexcitability, convulsions, falling on its side with its legs alternately extended and relaxed. Death may occur during the convulsions. Frothing at the mouth and profuse salivation are evident. If either disease is suspected, treat with subcutaneous administration of commercially available solutions that contain both calcium and magnesium.

2.10.2 Meningitis

Meningitis is usually an extension of bacterial pneumonia, most commonly *Histophilus somni* (formerly *Haemophilus somnus*), but possibly *Listeria monocytogenes*. *Histophilus somni* can cause an acute, often fatal, septicaemic disease that can involve the respiratory, cardiovascular, musculoskeletal, or nervous systems, either singly or together. Affected cattle are usually found dead but may display premonitory nervous signs from thrombotic meningoencephalitis associated with septicaemic episodes.

2.10.3 Tick fever

Of the three organisms, *Babesia bovis*, *Babesia bigemina* and *Anaplasma marginale*, that cause tick fever in Australia, *Babesia bovis* is responsible for about 80% of outbreaks. *Babesia bovis* may manifest as nervous signs if parasitised red blood cells block capillaries in the brain. Shipboard cattle may be affected by tick fever if they were incubating the disease during transport and loading. Cattle must have had exposure to cattle ticks in the previous one to four weeks. Clinical signs of tick fever caused by the two babesias include fever, anaemia, jaundice and red urine and deaths usually occur. With anaplasmosis there is mild fever, anaemia and jaundice but no red urine and deaths are rare. Early treatment with imidocarb usually results in a rapid recovery; treatment with tetracycline antibiotics may

reduce severity of symptoms if imidocarb is unavailable. Vaccines are available to assist prevention.

2.10.4 Grain poisoning

If severe, grain poisoning can cause staggering and blindness, probably related to hypocalcaemia and haemoconcentration. The exact pathophysiologic basis of the blindness is unknown.

2.10.5 Poisoning with lubricants, fumigants or exhaust gases.

Lubricants and fumigants will likely have contaminated feed; exhaust gases should be suspected if there is proximity to a combustion engine.

2.10.6 Polioencephalomalacia

Polioencephalomalacia from dietary changes resulting in reduced thiamine or high sulfur intake can cause listlessness, incoordination, ataxia, progressive blindness, head pressing and opisthotonus. The condition may occur in individuals or as an outbreak. Differential diagnoses for cattle include lead poisoning, water deprivation, salt poisoning, Histophilus meningoencephalitis, coccidiosis with nervous involvement, and vitamin A deficiency.

Treatment, if given early, with injections of thiamine usually results in rapid improvement and eventual recovery. Non-steroidal anti-inflammatory drugs may assist. Gradual dietary changes may prevent occurrence.

2.11 Prolonged recumbency

In shipboard cattle, involuntary sternal recumbency unrelated to parturition is most likely the result of:

- musculoskeletal injuries (including footrot or sepsis in multiple feet)
- toxaemia such as from pneumonia or peritonitis
- exhaustion from heat or physical exertion
- metabolic problems such as hypocalcaemia, hypomagnesaemia or ketosis
- dehydration from diarrhoea or rumen acidosis
- ephemeral fever

‘Downer cow’ is the term applied to mature dairy cows that are still recumbent 3 hours after calving despite treatment for hypocalcaemia. This situation is unlikely to occur under current export conditions.

With musculoskeletal injuries, the animals will be bright and alert; with the other conditions, the animals will have an abnormal demeanor. Vigorous intervention is required to get recumbent animals standing before compressive musculoskeletal damage becomes irreversible. Specific treatment of downers will be determined by the suspected diagnosis but in general they should receive antibiotics, anti-inflammatory drugs, calcium and magnesium solutions and nursing, especially to maintain hydration. Try to relocate the animal or its pen mates to create a pen of its own for nursing and where it won’t be trampled or knocked down. Roll the animal from side to side every few hours to reduce compression damage to limb muscles. The prognosis is better for animals that crawl or attempt to rise than animals that remain inactive. Strong consideration should be given to destroying cattle unable to rise and showing no improvement within 24 hours of treatment.

2.11.1 Ephemeral fever

This is an insect transmitted viral disease also known as three day sickness affecting the musculoskeletal system of cattle mainly in the northern Australian wet season. There is the possibility that animals incubating the disease may be loaded on board. The first sign is usually multiple animals, (up to 80% of a group) showing shifting lameness or difficulty rising. Other signs include prolonged recumbency, fever, inappetance, lachrymation, salivation. Severest cases are large framed and heavily muscled. Complications associated with prolonged recumbency cause deaths in a small percentage of animals. Treat recumbent animals for hypocalcaemia and with anti-inflammatory drugs, and nurse - don't stress or work. Oral rehydration should be avoided if swallowing is compromised. Mildly affected animals recover in several days without intervention. A vaccine is available to assist prevention.

2.12 Straining

The likely causes of straining in shipboard cattle include:

- prolapse of vagina or rectum from advanced pregnancy, over-fatness or persistent coughing
- rectal mucosal irritation from chronic diarrhoea
- urethral obstruction

Intrapelvic pressure associated with advanced pregnancy, over-fatness, persistent coughing or prolonged recumbency may induce partial prolapse which leads to mucosal injury, straining and complete prolapse of the rectum, vagina or both. Post-partum injuries, urinary tract obstruction in males and rectal mucosal irritation from chronic diarrhoea may also cause straining and prolapse of rectum and vagina.

Attempt to replace and fixate, or amputate prolapses if facilities and equipment are available. Prolapse of the vagina is usually most appropriately reduced and retained by insertion of a perivulvar Buhner's suture. Prolapse of the rectum, unless very small, is best amputated.

Amputation can be performed after placing a series of U-sutures around the base of the prolapse. A 23cm Gerlach needle carrying two 30cm lengths of heavy duty absorbable suture (sutures 1 and 2) is inserted into the lumen of the prolapse and the prolapsed tissue penetrated from the inside to the outside. The Gerlach needle is then used to carry the inner end of suture 2 and a new suture 3 from the lumen to the outside about 3 cm from the first penetration. The Gerlach needle is then used to carry the inner end of suture 3 and a new suture 4 from the lumen to the outside about 3 cm from the second penetration. Suturing continues in this manner for the circumference of the prolapse until there is a series or U sutures around the prolapse. Each suture is tightened and tied, then the prolapse excised about 2 cm distal to the sutures. No haemorrhage occurs due to the ligation of the tissues. Spontaneous retraction of the stump occurs.

Simultaneously treat any underlying cause such as pneumonia, urolithiasis or diarrhoea. Prompt euthanasia is recommended if the prolapse cannot be corrected.

3 Investigation of sick cattle

3.1 Be aware of diseases and conditions causing sickness

Review Table 2.1 and section 2 to become familiar with syndromes affecting cattle on long-haul voyages and the diseases that may cause these syndromes. Veterinarians need to be aware of these syndromes and diseases and the circumstances of their occurrence when screening for and diagnosing sick cattle during export voyages. Veterinarians also need to be aware of disease reports from cattle assembly points and the need to expect the unexpected.

3.2 Be aware of predisposing risk factors for sickness

Table 3.1 provides a list of risk factors that predispose to disease in ship board cattle either by reducing the animal's resistance or increasing exposure to the disease causing agent or both. The risk factors are divided into Animal, Management and Environmental risk factors for ease of consideration. Note that multiple factors may be operating concurrently.

Table 3.1: Animal, management and environmental risk factors that may predispose cattle to becoming sick on board a cattle ship

Animal	**Management**	**Environment**
Age	Feed quality and quantity	Temperature
Sex	Water quality and quantity	Humidity
Breed	Pen location (incl relocation)	Wind direction
Size	Drug, chemical and vaccination treatments	Pen floor surfaces
Pregnancy	Feeding system (incl trough height and area)	Walking surfaces i.e. laneways
Lactation	Watering system (incl trough height and area)	Ventilation
Weight	Skills, knowledge & experience of stock persons/crew (incl change in stockpersons/crew)	Shelter
Height	Distances walked	Pen stocking rate/crowding
Hair coat length	Applications of fumigants	Shade
Temperament	Deck cleaning	Ectoparasites
Vaccination status		Noise i.e. from engines, fan motors
Origin		Pollution
Body condition		People traffic
		Lighting intensity/duration

4 Monitoring and investigating sick cattle

4.1 Step 1. Screen cattle for sickness

Screening cattle for diseases on board ship can be challenging because of the difficulties in observing individual cattle, especially when pens are crowded. Obscured views in crowded pens, hair coats heavily laden with manure, dim lighting and difficulties in monitoring individual suspect cattle are constraints on some ships. In theory, the cattle in a field of view will change over time as they move around the pen to feed and water, however, it is well to be aware that pecking orders, and weakness, may prevent sick cattle from readily relocating in a pen. This can leave them potentially unobserved and undetected.

The following comparative observations between pens and between individuals within pens provide a checklist for use during routine pen inspections.

Between pen (group) comparisons:

- Amounts of unconsumed feed in feed troughs
- Numbers of cattle chewing their cud
- Numbers of recumbent versus standing cattle
- Faecal consistency
- Urine colour
- Colour and consistency of manure on floor of pen particularly blood staining
- Amount of discharges in feed troughs (causing wet feed) and on pen rails
- Respiratory rates, coughing levels and mental demeanor
- Skin temperature as measured by distance-reading infrared thermometer[12]
- Manure contamination of hair coats

Within pen (or individual) comparisons:

- Posture and demeanor
- Respiratory rates
- Skin temperature as measured by distance-reading infrared thermometer
- Urine colour
- Faecal consistency
- Prolonged recumbency, reluctance to rise or difficulty rising (*recumbent cattle chewing their cud and ruminating are unlikely to be sick or in pain. Recumbent animals are unlikely to lie on a sore foot or leg so check the outstretched foot and leg carefully*).
- Non or partial weight bearing of limbs when standing (*Scanning across the backs of cattle may detect dropped shoulders or hips; scan of legs may detect animals standing with legs partially flexed; best time to scan legs is immediately after deck washing when cattle are standing and legs and deck are clean – use a torch.*).

Observe for clear cut signs of sickness in a pen including:

- Swellings or discharges affecting heads, feet, flanks and rumps detected *in the sample of cattle in the field of view*.
- Blood stained faeces

[12] There is much variability in quality of distance-reading thermometers

Be aware that some sick cattle will be suffering concurrent diseases such as footrot and IBR and hence may present with a confusing clinical picture.

Use timing of observations to advantage:

- before feeding — detects uneaten feed
- during feeding — detects animals that are low on the pecking order or inappetent or both
- post feeding — detects stock not resting and ruminating (healthy stock would normally rest and ruminate)
- post deck washing — detects lameness and limb injures (for the short period (15min) post deck washing, stock remain standing and legs are clean making it a good time to examine for lameness and injuries – use a torch

4.2 Step 2. Make specific observations and measurements

Make the following specific observations and measurements:

Respiratory rate and depth

- Note number of breaths per minute, level of respiratory exertion (normal, panting, gasping) and whether breathing is with mouth open or closed
- Changes in respiratory rate and depth are potential indicators of early bloat, pneumonia, pleurisy, heat stress
- Respiration rate and panting score as shown in Table 4.1[13] can be useful indicators of heat load in cattle

Table 4.1: Breathing condition and panting score for heat stress in cattle

Breathing condition	**Panting score (PS)**	**Associated respiration rates (breaths/min)**
No panting – normal. Difficult to see chest movement	0	<40
Slight panting, mouth closed, no drool or foam. Easy to see chest movement	1	40-70
Fast panting, drool or foam present. No open mouth panting	2	70-120
As for 2 but with occasional open mouth, tongue not extended	2.5	70-120
Open mouth + some drooling. Neck extended and head usually up	3	120-160
As for 3 but with tongue out slightly, occasionally fully extended for short periods + excessive drooling	3.5	120-160
Open mouth with tongue fully extended for prolonged periods + excessive drooling. Neck extended and head up	4	>160
As for 4 but head held down. Cattle 'breathe' from flank. Drooling may cease	4.5	Variable - RR may decrease

[13] Adapted from: *Recognising excessive heat load in feedlot cattle*. tips & tools, Feedlots. Meat and Livestock Australia. Source: www.mla.com.au/TipsToolsRecognisingexcessiveheatloadinfeedlotcattlereprintOct2006.pdf

Faeces

- Note consistency (i.e. firm, dry, soft, sloppy, watery), smell (i.e. sweet, putrid), colour (i.e. black, grey, green) and contents (i.e. grain, blood, mucus, fibrin).
- Changes in consistency and contents are potential indicators of under-eating, overeating, indigestion, infection (salmonella, coccidiosis)

Urine

- Note colour of urine (i.e. clear, yellow, orange, brown, port wine)
- Changes in colour are potential indicators of dehydration, fever, muscle damage, tick fever

Feed consumption

- Feed consumption can be assessed by examining amount of feed remaining in troughs. Routine observations can detect pens but not individual cattle that are not eating.
- Average feed consumption for the whole ship is a general indicator of stock comfort but can be overestimated if feed troughs are emptied and cleaned before replenishment. Individual deck or group consumption rates may be able to be calculated.
- Note cud chewing, ruminations and nose licking. Healthy, well-fed cattle chew their cud, lick their noses and have strong, regular rumen contractions detectable by observing their left flank. Sick or stressed cattle don't chew their cud, have weak, infrequent rumen contractions or none at all and dirty noses.

Water consumption

- Water consumption is usually only able to be calculated from the ships gross water consumption divided by the number of head on board. The figure is a guide but can be an overestimate if water troughs are emptied and cleaned before replenishing. Individual deck or group consumption rates are usually not able to be calculated.
- Changes in water consumption are potential indicators of heat or cold stress.

4.3 Step 3. Categorisation of sick cattle into syndrome, and suspected disease or condition

Refer to Table 4.2 for assistance in categorising sick cattle into a syndrome, suspected disease or condition based on clinical signs and history.

Table 4.2: Signs and history to look for when developing diagnostic suspicions in sick cattle aboard ships

Disease/condition	What to look for
1. Nasal discharge	• Mucopurulent nasal discharge that may or may not be accompanied by erosion and crusting of nares and nasal pad • With infectious bovine rhinotracheitis (IBR), look for bilateral nasal and eye discharge, fever, erosion and crusting of nares and nasal pad, and coughing • Inappetent non ruminating cattle mucus-laden, dirty, crusty appearance of nostrils and nasal pad from not licking • Check feed for dustiness
2. Respiratory distress	• Change in respiratory rate and depth accompanied by fever ± cough and respiratory sounds • Open mouth breathing with tongue protrusion • With heat stress cattle will be panting, drooling, hot to touch with skin and rectal temperatures >42.0 C. *Bos indicus* cattle much less affected • Check proximity to exhaust gases and fumigants • Pneumonia is difficult to diagnose in cattle and to differentiate from heat stress and IBR; fetid breath may originate in sinuses, mouth, trachea, lungs and stomach; expect cases of pneumonia, IBR and viral stomatitis to have fetid breath
3. Lameness	• Lameness and swelling in one or more feet and legs ± fever • Check flooring for hazards such as broken anti-slip mesh or holes, and abrasiveness • History of long distances of forced walking on abrasive flooring and turning corners may cause excessive sole wearing • Constant walking and lying in wet manure will predispose to footrot and decubitus ulcers/infections
4. Watery eyes	• Unilateral or bilateral lacrimal discharge • Ulcer visible on cornea in pinkeye and foreign bodies; corneal ulceration is rare in IBR • *Bos taurus* breeds probably more susceptible to pink eye • Corneal opacity in pinkeye and foreign bodies • Check for dusty feeds or feeds containing chaff or seeds i.e. hay
5. Alopecic skin lesions	• Multiple bare circular patches developing on skin • Stephanofilariasis lesions are more concentrated on ventral neck • Pseudolumpy skin disease lesions are generally distributed • Ringworm lesions are more concentrated on the head and neck • Dermatophilosis occurs on skin areas that have been persistently wet
6. Illthrift	• Reduced eating and ruminating • Tucked up, hollow gutted appearance • Absence of diarrhoea and other signs of illness • Check response to feeding hay/chaff, changing stocking density and adjusting trough height

Table continued next page

Table 4.2: continued

Disease/condition	What to look for
7. Distended abdomen	• Check the left flanks of cattle • With bloat, left flank over area of rumen distended by gas, history of feeding low fibre diet • Oesophageal obstruction will be accompanied by regurgitation from nostrils; history or observation of feeding vegetables or fruit galley waste • Advanced pregnancies and vagal indigestion will cause abdomen to be pear shaped; reduced or absent rumen movements in latter, ballotment of foetus possible in former • Urinary obstruction may be accompanied by straining, ventral swelling and oedema
8. Knuckling	• Knuckling of fetlock joint in one or both hind legs • Bilateral is usually indication of lumbar spine injury from being ridden or accident • A dropped hock is usually indication of ruptured gastrocnemius tendon • Hard uneven flooring will predispose to peroneal nerve paralysis i.e. iron mesh on concrete
9. Nervous disease	• Nervous signs: trembling, ataxia, disorientation and blindness • Hypocalcaemia/hypomagnesaemia cases will show some response to calcium/magnesium treatment • Tick fever cases may be anaemic, jaundiced, have red urine, & come from northern Australia • Bacterial meningitis cases (i.e. *Haemophilus somni*) may also have respiratory disease and swollen joints • Cases of grain poisoning cases will have diarrhoea • Polioencephalomalacia manifests as blindness, depression and ataxia
10. Prolonged recumbency	• Animals lying down for long periods i.e. >3 hours, not chewing cud, sometimes in full lateral recumbency • With ephemeral fever, multiple well-muscled animals affected with temporary recumbency or lameness plus fever but without signs of limb or foot injury or infection and originating from northern Australia, heavy animals affected more severely • Localised swelling present in musculoskeletal injuries, footrot and foot sepsis of outstretched legs
11. Straining	• Look for animals with arched backs that indicate straining • Prolapse of vagina or rectum will be obvious • Urethral swelling and oedema (water belly) indicates ruptured urethra following urinary tract obstruction or trauma

4.4 Step 4. Complete a Daily Health Report noting morbidity cases, rates and predisposing factors

Useful information about diseases and conditions on board can be made from the observations by stockmen and veterinarian**s** that contribute to **daily voyage reports**, and by daily monitoring of the number and type of **cattle occupying hospital pens** and the **amounts** of different types of **antibiotic** and **anti-inflammatory drugs** administered.

It is very important to gather epidemiological information about diseases including information about the affected animals and about the population of animals at risk (all animals on the ship).

At the end of each day complete the **Daily Health Report** with the following information:

1. Estimate of **number and percentage** of cattle observed affected with the **different** suspected diseases/conditions.

2. For each disease condition observed, record:

- **what type/class of animal** is the disease condition mostly occurring in and what type/class of animals seem to be spared.
- **where** on the ship the condition is mostly occurring and where it is not occurring
- **when** was the onset of the disease condition

3. For each disease condition observed, record the suspected:

- **animal factors** that are suspected to be predisposing and protective
- **management factors** that appear to be predisposing or protective
- **environmental factors** that appear to be predisposing or protective

5 Investigation of dead cattle

This section of the handbook provides information to guide investigation cause of death in cattle exported by sea. It contains procedures for investigating the cause of death including necropsy examination, sample collection and identification of predisposing factors. It also contains terminology and descriptions for common diseases and conditions causing death in live export cattle. The information in this handbook is designed to complement the existing Stockman's Handbook - Transport of Cattle by Sea.[14]

5.1 Preparations for necropsy

5.1.1 Be aware of diseases causing death and their key necropsy findings

Table 5.1 shows a list of common diseases and conditions associated with mortalities in cattle aboard ships and what to look for at necropsy.

[14] Stockman's handbook – transport of cattle by sea, short and long haul voyages. Ross Ainsworth. LiveCorp. April 2008

Table 5.1: Diseases and conditions causing mortality on cattle ships and the key necropsy findings

Disease/Condition	Key necropsy findings
Abomasal or intestinal torsion	• Discoloured, distended viscera with twist palpable at root
Blackleg	• Blackened muscle tissue in heart or skeletal muscles or both • gas under skin of upper legs or back
Bleeding abomasal ulcer	• Deep ulcer in abomasal lining • White mucous membranes from anaemia • Black tarry intestinal content or faeces
Bloat	• Rumen extremely distended with gas • Severe head, neck and inguinal congestion
Caudal vena caval syndrome	• Liver abscess burst into caudal vena cava • Haemoptysis and swallowed blood clot in rumen
Enterotoxaemia	• No strong gross diagnostic features. History of sudden death with nervous signs in young unvaccinated cattle on *ad libitum* high carbohydrate diet and absence of significant necropsy findings are suggestive. Unlikely to occur in shipboard cattle but has been suspected.[15] Changes related to increased vascular permeability of cavity linings and brain may be present i.e. increased volume of pericardial, thoracic and/or peritoneal fluid containing fibrin, flattening of gyri of brain and coning of cerebellum may be suggestive.
Fatty liver disease	• Fat animal • Liver and kidney pale swollen, soft and friable
Hyperthermia/heatstroke	• Internal and external carcass are hot to touch • Core body temperature measures >43^{o}C when measured in heart, liver or deep rump muscle • Recent hot and humid pen conditions • Pink coloured flesh (cooked); heart is in state of contracture • Lungs red/dark but soft and spongy
Obstruction by intestinal phytobezoar or foreign body	• Presence of phytobezoar in intestine or pylorus • Fluid accumulation anterior to phytobezoar/foreign body; shrunken intestine below phytobezoar with sparse, mucus-coated contents
Other	• Unusual colour, size, shape, smell or arrangement of organs or tissues or both

Table continued next page

[15] Enterotoxaemia has been suspected as the cause of sudden death in shipboard cattle after cattle decks have been washed and food consumption increases with the cooler conditions.

Table 5.1: continued

Peritonitis following perforation of abomasal/intestinal ulcer	• Fibrin on viscera • Abomasal or intestinal contents in abdominal cavity • Presence of perforation in abomasal or intestinal wall
Pneumonia	• 50% of both lungs feel solid rather than spongy • Lungs coloured red or dark red • Fibrin sheets or strands on surface of both lungs • History of respiratory distress
Poisoning	• Poisons such as lubricants, disinfectants, fumigants, insecticides detectable in reticulum or rumen by sight or smell or both.
Rumen acidosis	• pH of rumen contents is <5.5 • large quantity of grain or pellets in rumen
Traumatic reticuloperitonitis (hardware disease)	• peritonitis evident as fibrin, pus, adhesions affecting reticulum and diaphragm where they contact. • peritonitis may become diffuse throughout abdomen • wire, nail or needle may be found in lumen or wall of reticulum • suppurative pericarditis and localised pleuritis may be present if diaphragm and pericardium penetrated
Salmonellosis	• Diarrhoea ± dysentery • Thickened and reddened intestinal mucosa, septic tank odour • Swollen, oedematous draining mesenteric lymph nodes
Septicaemia	• Likely extension of wound infection from sole abscess or decubital wounds • Swelling, discolouration and foul smelling tissues originating and extending from wound/s
Starvation	• Muscle wasting; Empty rumen; Depleted fat tissue; Serous atrophy of fat • Hypoplastic liver and gall bladder
Tick fever	• Yellowing of viscera, watery blood, enlarged spleen ± red urine • Presence of animals on board that originate from tick area
Traumatic injury including asphyxia, broken neck	• Indicative posture or presence of fractures and dislocations or both • Subcutaneous bruising

5.1.2 Be aware of predisposing risk factors for death

Review Table 3.1 for a list of risk factors that predispose to deaths in ship board cattle. Be aware of these risk factors when attempting to determine the predisposing factors that may have combined to cause death.

5.1.3 Equipment needed

Information about equipment for performing necropsies on board an export vessel and carrying equipment to and from a necropsy site, is provided in Section 7.9 and 7.10.

5.1.4 Necropsy and Sampling Protocols

A **Necropsy/Dead Cattle Report** should be completed for all dead cattle – including those deaths where a necropsy is not done.

Note that even if all dead cattle cannot be necropsied it is important to complete a dead cattle/necropsy report for all dead cattle as a way of recording all deaths.

It is generally not possible to necropsy all dead cattle, and the following protocols ensure sufficient necropsies are performed to characterise causes of death while minimizing the overall burden on AAVets and stockmen:

Necropsy protocol:

- **Targeted necropsy** refers to a partial necropsy designed to provide gross examination (and description) of the minimum set of organs and tissues to characterise most causes of death. Involves examination of chest and abdominal cavities in all cases and additional tissues only if indicated by history, clinical signs or initial findings.
- **Comprehensive necropsy** refers to a complete necropsy and a comprehensive sampling strategy. Performed when there is no obvious cause of death to ensure maximal likelihood of subsequent laboratory examination identifying the cause of death.

Number of animals to necropsy:

- Where multiple deaths occur from the same disease syndrome and around the same time (within 1-2 days), necropsy three representative animals only.
- If the same disease or syndrome continues to be associated with deaths over subsequent days or later in the voyage, conduct additional confirmatory necropsies at a lower rate (one per 1-2 days) from those animals.
- If at any stage there is suspicion of a different disease syndrome, then conduct necropsies of three representative animals i.e. follow the same general protocol.

Sampling protocol:

The approach to sample collection at necropsy has been developed to minimise the number of samples and time required to collect samples, while ensuring a minimum standard of samples from every necropsy.

- **Sampling from Targeted Necropsies**
  - **Core samples** should be collected from every necropsy. A minimum sample set that helps ensure consistent and quality results from laboratory examination of samples to determine cause of death.

- **Additional samples** may be required in addition to the core samples, depending on the suspected cause of death

- **Sampling from Comprehensive Necropsies**
  - Comprehensive necropsies are performed when there is no obvious cause of death from clinical signs, history and initial necropsy, and should be accompanied by a full set of samples.

It is expected that almost all necropsies performed during voyages will be targeted necropsies accompanied by the Core set of samples.

5.1.5 Be familiar with photographic requirements before commencing a necropsy

Experience indicates that digital photographs provide extremely valuable information to aid in identifying cause of death. The most useful photographs include:

1. Dead cattle in situ before they are relocated or dismembered with the case number on a small placard or the NLIS tag number in the photograph captured in the photograph.
2. Each of the major body cavities (i.e. oral, thorax, abdomen) at end of display stage (see necropsy protocol) even if no lesions are evident.
3. Organs and tissues where there are gross changes suspected to be caused by disease

More information on taking necropsy photographs on cattle ships is presented in Section 7.3.

6 Bovine necropsy protocol

This Handbook provides a description of a method of performing a bovine necropsy suitable for ship board conditions. There are many ways to do a necropsy and procedures must be adapted to the conditions operating at the time. The method described here takes into consideration the following conditions:

- Gut tissues may be sampled early in the necropsy to minimize postmortem changes especially if enteric disease is suspected.
- Core body temperature must be measured early in the necropsy especially if hyperthermia is suspected.
- The carcass is likely to be lying in accumulated bedding and manure that may risk gross contamination of equipment & samples.
- The carcass must eventually be fully dismembered for ease of disposal and it is unnecessary to salvage the hide.

The description is for a necropsy conducted with the left side down so that the rumen lies under the abdominal viscera. If the animal is found right side down, only roll it over if pen conditions permit, and if it is a large animal, you have assistance.

Necropsies should be performed systematically and comprehensively, however it is recognized that time is not always available to do this. A systematic comprehensive approach using checklists will minimise the risk of not collecting important samples and reduce bias of investigators.

6.1 Short summary of bovine necropsy

This section presents a short, summary version of a bovine necropsy, intended as a rapid review or guide. The following section then provides a detailed description of the same procedures.

Bovine necropsy is best approached in four sequential stages: 1. Animal characterization and history assessment, 2. External examination and sampling, 3. Dissection and display, 4. Internal organ examination and sampling.

6.1.1 Stage 1: Animal characterization and history assessment

1. Examine the carcass and record characteristics such as:
   - estimated weight in kg
   - condition (1=emaciated, 2=backward store, 3=store, 4=forward store, 5=fat)
   - hair coat length (short = summer coat, medium, long = winter coat)
   - identification (NLIS tags, management tags, tattoos, earmarks, etc)
   - age (see Section 7.3 for information on use of teeth to estimate age).
   - sex
   - breed
   - extent of post mortem decomposition
   - postural predicament (is animal cast or stuck).

2. Take a digital photograph of the undisturbed carcass including an ear tag or other case identifier.

3. Obtain a history including:
   - Record **when** and **where** the animal became sick and died.
   - Record the management, environmental and animal risk factors that may have occurred in the days or weeks leading up to the time and location of death.

6.1.2 Stage 2. External assessment

Cut out NLIS and management tags, clean them and place them into one of the formalin containers to be used for that necropsy.

Label all specimen containers with the case number using indelible ink.

Examine (& photograph) external organs in the following sequence and collect samples concurrently according to sampling protocol (see later).

1. The head: eyes, conjunctiva, nose, ears including canal, mouth including lips, gums and tongue for erosions, ulcers or blisters and make an initial estimate of the age from the eruption and wear of incisor teeth.

2. The skin: superficial lymph nodes, anus, vulva, prepuce, skin of ventral abdomen and neck.

3. The limbs: joints, bursae, wounds, coronets and interdigital spaces.

6.1.3 Stage 3: Dissection and display

Dissect the carcass to display but not disturb the contents of the *oral, thoracic and peritoneal cavities.*

Note any accumulations of fibrin or fluid, the state of nutrition, presence of any carcass discolouration, presence of any organ or tissue colour, size or configuration changes.

Take a photograph of each cavity and close-up photographs of any changes in organs that you think are important

6.1.4 Stage 4: Internal organ examination and sampling

Examine organs in a systematic way and collect samples concurrently according to sampling protocol.

1. Abdomen: abdominal alimentary tract (rumen, reticulum, omasum, abomasum, small intestine, large intestine, caecum, colon, rectum), **then**: liver, gall bladder, spleen, pancreas, mesenteries, omentum, diaphragm. But sample intestines first.

2. Oral cavity: tongue, larynx

3. Neck: oesophagus, trachea

4. Thorax: lungs, heart

These organs may be examined and sampled before or after removal from the carcass, as serves best.

5. Abdomen revisited – adrenals, kidney, bladder, genital organs, foetus

6. Head - oral cavity, teeth, nasal cavities, middle ears

If protocol dictates, remove head to sample brain or brainstem

7. F**eet and limbs** – soles, white line, interdigitum, swollen joints, other swellings, muscle, bone marrow

8. Spinal column – spinal cord (only if protocol dictates)

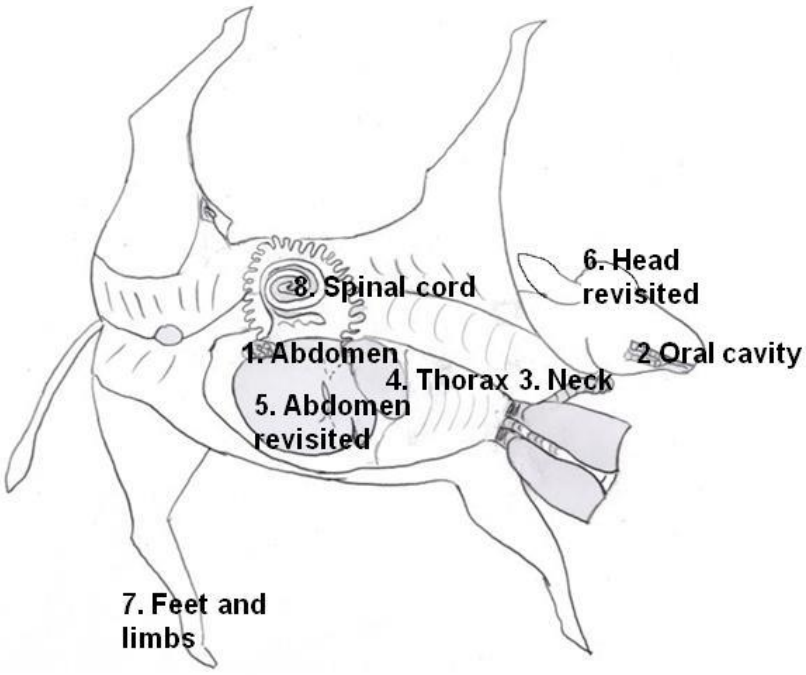


Figure 6.1: Necropsy examination sequence for shipboard necropsy

Variations to this procedure may be required for certain conditions where postmortem changes must be avoided for correct interpretation. If heat stroke is suspected measure core temperature as soon as possible after death. If enteritis is suspected, exteriorize intestine as soon as abdomen is opened and collect samples for histology and microbiology.

6.2 Sampling protocols

Two protocols exist for sample collection, one for targeted sampling and one for comprehensive sampling. Targeted rather than comprehensive sampling is likely to be much more commonly undertaken on routine voyages.

Guidelines for collection of samples are as follows:

Formalinised samples for histology

- Take samples from the margins of lesions to obtain normal and abnormal tissue in the one piece, plus separate pieces of normal and abnormal tissue from the same organ.
- Use ten volumes 10% buffered formalin to one volume of sample for three days at room temperature for fixation. Do not refrigerate. The volume of formalin can be reduced later for transport of samples.
- Samples from solid organs such as liver, kidney and spleen should not exceed 1 cm thickness. **Blocks of 2cm x 2cm x< 1cm are best.** Mesenteric lymph nodes, adrenals and thyroids should be split.
- Samples from intestines should be incised lengthwise to ensure penetration of fixative to the inner surface. Short **3cm lengths of intestine** are sufficient. For larger viscera such as gall bladder, ruminoreticulum or abomasum take a **2cm x 2cm section of the wall**.
- Samples of **rumen** should be ventral rumen and include a pillar

Samples for PCR testing

- Collect swabs or tissue into viral transport media & store frozen

On-the-spot tests

- Measure core body temperature with a deep probe thermometer inserted into the heart, liver or deep rump muscles as soon after death as possible.
- Test pH of rumen fluid with pH strips or dipstick
- Test for urinary ketones with a dipstick

6.2.1 Targeted sampling

A baseline set of **CORE SAMPLES** and data is to be collected from every necropsy regardless of suspected disease.

These samples are important to differentiate the most common and important causes of death in export cattle.

Table 6.1: Core samples to be collected from ALL necropsies.

<table>
<tr><th>Sample/measurement</th><th>Sample Container</th><th>Sample Storage</th></tr>
<tr><td>1. Core body temperature</td><td>N/A</td><td>N/A</td></tr>
<tr><td>2. Nasal swab</td><td rowspan="2">Viral transport media</td><td rowspan="2">Freeze</td></tr>
<tr><td>3. Lung swab</td></tr>
<tr><td>4. Lung – bread slice</td><td rowspan="8">10% formalin</td><td rowspan="8">Room temperature</td></tr>
<tr><td>5. Trachea</td></tr>
<tr><td>6. Heart</td></tr>
<tr><td>7. Kidney</td></tr>
<tr><td>8. Liver - bread slice</td></tr>
<tr><td>9. Ileocaecal valve - opened</td></tr>
<tr><td>10. Ventral rumen - including pillar</td></tr>
</table>

ADDITIONAL SAMPLES and observations made when certain diseases are suspected :

Suspected diseases presented in alphabetic order

Suspected disease	Targeted samples or additional measurements
Blackleg	Skeletal muscle in 10% formalin
Fatty liver	Urinary ketones (dipstick)
Heat stroke	Skeletal muscle in 10% formalin
Pneumonia	Lung (affected and unaffected) in viral transport media, freeze
	Swab of affected lung, freeze
Rumen acidosis	Reticulum in 10% formalin
	Rumen fluid pH
Salmonellosis	Gall bladder in 10% formalin
	Small intestine wall in 10% formalin
	Large intestine wall in 10% formalin
	Mesenteric lymph node in 10% formalin
	Reticulum in 10% formalin
	Abomasum in 10% formalin
	Rumen fluid pH
Septicaemia	Spleen in 10% formalin
	Swab of tissues affected by cellulitis, freeze
Starvation	Pancreas in 10% formalin
	Skeletal muscle in 10% formalin
	Urinary ketones (dipstick)
Tick fever	Brainstem in 10% formalin
	Spinal cord at C1 in 10% formalin
	Spleen in 10% formalin

6.2.2 Comprehensive sampling

Use the comprehensive sampling approach when there is no obvious cause of death on initial necropsy.

Collect the following samples in 10% formalin for histology

- Brainstem and spinal cord at C1 using prionics spoon
- Trachea & Lung
- Heart
- Liver
- Gall bladder
- Spleen
- Adrenal gland
- Pancreas
- Kidney
- Rumen & Reticulum & Abomasum
- Small Intestine & Large Intestine
- Mesenteric lymph node
- Skeletal muscle
- Bone marrow

Conduct the following on the spot tests

- Urine for ketones
- Rumen fluid pH
- Core body temperature

Other samples (may be useful in some cases)

NOTE: For necropsies conducted at sea, import restrictions make it difficult to bring non-fixed samples back into Australia and these samples should not be collected without prior arrangement for importation.

- **Toxicology** (place in individual Ziploc bags and freeze)
  - Contents of reticulum, fresh kidney , fresh liver
- **Microbiology and molecular biology**
  - Samples in appropriate transport media and stored frozen.
- **Clinical pathology and biochemistry** (place in tubes and freeze).
  - Serum, vitreous humor, cerebrospinal fluid

6.3 Detailed necropsy procedure

The detailed necropsy procedure describes a systematic and comprehensive approach to a full necropsy.

The targeted sampling approach described in the previous section is considered more appropriate for necropsies performed during a voyage. The approach is based on opening the thoracic and abdominal cavities and collecting the core samples (Table 6.1). Additional samples may be collected depending on the tentative diagnosis.

A comprehensive necropsy is likely to be done only when there is no obvious cause of death on initial necropsy.

6.3.1 Before beginning

- Collect a history before proceeding with the necropsy. Define the nature of the problem (symptoms and signs, incubation period, duration of illness, numbers recovering and numbers dying), what animals are affected (number, age, breed, sex, physiological and vaccination status) and when (start and duration of the problem, duration of the clinical course) and where they occurred.
- Record relevant environmental conditions and management practices such as weather and feed changes, deck wash downs and treatments and responses to treatment. A good history examination will direct focus on certain elements of the necropsy if time is limiting.
- Examine sick cattle systematically before being euthanased. Record clinical information such as blindness, weakness, ataxia, jaundice, diarrhoea and respiratory distress and rectal temperature. Elevated rectal temperature may indicate acute infection, exertion or hot and humid environmental conditions.

6.3.2 At the beginning

- Assess and record the animal's physical condition and the extent of post mortem decomposition. Observe whether there are any discharges from eye, nose, ear, mouth, superficial lymph nodes, anus, vulva, prepuce, joints, bursae or wounds.
- Examine the skin, particularly of the ventral neck and ear canal for external parasites. Examine the coronets and interdigital spaces for signs of inflammation.
- Examine the conjunctiva for discolouration.
- Examine the lips, gums and tongue for erosions, ulcers or blisters and make an initial estimate of the age from the eruption and wear of incisor teeth. *Refer to other sections for assistance with aging cattle by their teeth.*
- Note any identifying features such as earmarks, tags or brands.
- Cut out NLIS and management tags, clean them and place them into a container of formalin. Label the container with the case number.
- If hyperthermia (heat stroke) is suspected, make a stab incision over a large muscle mass and insert a probe thermometer.

6.3.3 First step — expose body cavities and viscera

- Reflect the upper front limb by cutting through the skin and muscles of the armpit. The reflected armpit will serve as a table.
- Reflect the right hind limb by cutting through skin and muscle of the right groin to expose the hip joint. Incise the joint capsule, dislocate the joint and force the leg back. Make a cut down the length of the femur to expose the diaphysis for later sampling of bone marrow.
- Skin the right side chest and abdomen starting with an incision along a line at a level connecting the middles of the humerus and femur prior to their reflection. Reflect the skin ventrally and dorsally.
- Skin the right side neck and head. The incision should run in a line from the level of the arm pit to the tip of the mandible. Reflect the skin dorsally and ventrally to expose the jugular groove, trachea, molars and submandibular area. Age the animal based on molar eruptions: 1^{st} = 6-12mo, 2^{nd} = 12-18mo, 3^{rd}=24-36mo.
- Expose the abdomen by cutting the right side wall of abdominal muscles along the caudal margin of the ribs, then along the lumbar area and back midline at the pelvis.

Reflect the abdominal wall ventrally to expose the abdomen. This approach will help avoid puncturing abdominal viscera.

- Cut the right diaphragm along its outer margin and observe if the lungs collapse. Failure of the lungs to collapse indicates lung disease.
- Cut along the right side rib cage as far dorsally and ventrally as possible with rib cutters to expose the thoracic viscera leaving first rib intact to serve as a hinge. The forward reflected rack of ribs will serve as a table to examine the heart and lungs if required.

If heat stroke is suspected, measure the temperature of the heart, liver and pelvic muscle mass at this point using a deep probe thermometer.

- Reflect the tongue and larynx caudally to expose the oropharynx cutting the joints or bones of hyoid apparatus with rib cutters to free the larynx.

Major dissection is now completed. The next steps involve a systematic process of examination, description and sample collection.

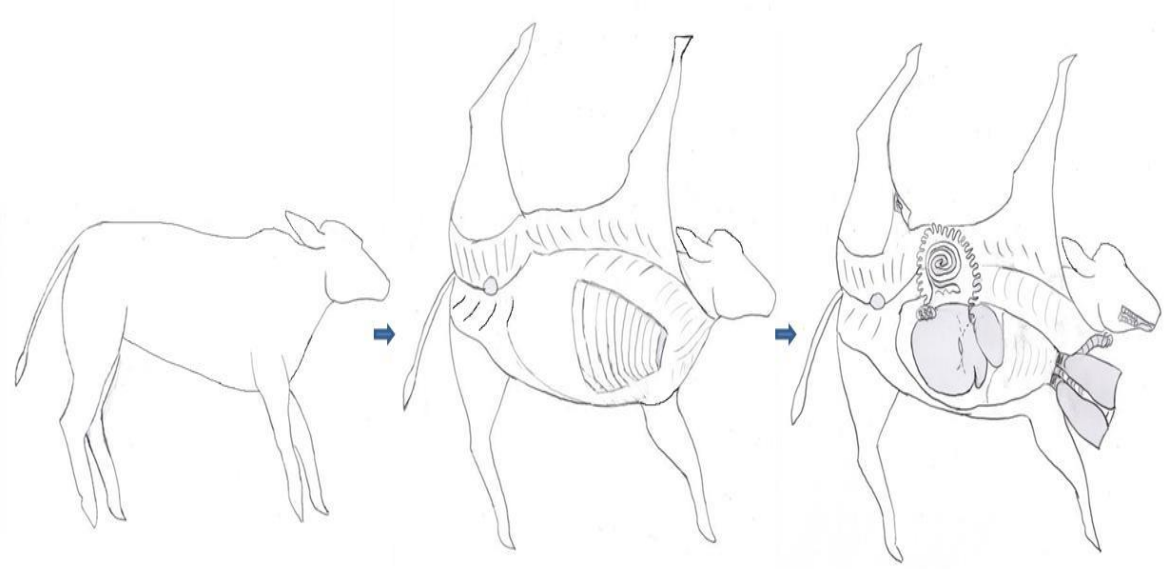


Figure 6.2: Major dissection steps to expose body cavities and viscera

6.3.4 Second step — step back

- Place sampling equipment and containers, voice recorder and digital cameras within easy reach.
- Carefully overview the visible organs. In particular note any adhesions or displacements, the distribution and extent of any lesions and any abnormalities of size, shape, surface, sound, smell, colour, contour, consistency and content.
- Check the body cavities and pericardial sac for abnormal collection of fluids.

6.3.5 Third step — examining and sampling the abdomen

As a general guide, it is best to open hollow viscera after solid viscera have been sampled to avoid contamination.

- Palpate the duodenum, jejenum, ileum, caecum, colon and rectum along their length.

The ileum, caecum and colon can be fanned out over the abdomen and lumbar region for closer systematic inspection.

Reddening of intestines alone does not mean that enteritis or enterotoxaemia is present. Simple postmortem change can cause this.

Thickening of the intestinal wall, watery or bloody contents and enlarged, oedematous draining lymph nodes will be present to some degree in enteritis.

- Examine the omentum and mesenteries including mesenteric lymph nodes, hemisecting at least three lymph nodes to examine cut surfaces.
- Find and expose the pancreas (embedded in the mesentery adjacent to the duodenum) and collect samples if required.
- Cut the attachments of the small and large intestines to the carcass and remove, thereby exposing the forestomachs, bladder and kidneys.
- Check the diaphragm for adhesions before palpating the forestomachs (rumen, reticulum, omasum and abomasums), spleen, liver and duodenum before cutting their attachments to the carcass allowing these to be rolled together from the abdomen and away from the carcass.

  Make handholds of the oesophageal groove and stabs in the rumen wall to pull on. Using the orifice of the oesophageal groove as a handhold also serves to stop it leaking fluid.

- Roll the forestomachs so that the spleen and liver are on top, out of the manure.
- Inspect the reticulum and diaphragmatic surface of the liver for adhesions.
- Palpate and slice the spleen in situ.
- Palpate the liver before dicing each lobe and examining cut surfaces. If required, collect samples of liver for histology (a sample from each lobe).
- Incise the gall bladder to examine the mucosa and bile
- After the spleen, liver and gall bladder have been examined, layout the forestomachs for systematic examination and sampling.
- The lining and contents of rumen, reticulum, omasum and abomasum can be compared by incising along the ventral aspect of the abomasum and other forestomachs in one continuous cut.

  Ventral mucosal surfaces are most likely to exhibit lesions and should be collected for histological examination. Lifting of strips of the mucosa of the rumen and reticulum can look spectacular but is normal post mortem change and should not be mistaken for rumenitis. Rumenitis is often only detectable microscopically.

- Closely inspect the reticular contents for foreign bodies such as wire or poisons such as lead.
- Measure pH of rumen content with a test strip. Normal pH range is 5.5 -7.
- Collect samples of the ventral walls of the rumen and reticulum if required.
- Cut the abomasum along its greater curvature through the pyloric valve into the duodenum to expose the mucosa.
- Examine the abomasal folds and duodenal mucosa collecting samples if required

6.3.6 Fourth step — examine the oral cavity and neck

- Examine the pharynx and exterior of the larynx and tongue before dicing the tongue.
- Separate the oesophagus and trachea from the other neck tissues to the first rib but maintaining their connections to the tongue and larynx
- Starting at the dorsal larynx incise the length of the trachea to the first rib and examine and sample as required.
- Incise the length of the oesophagus to the first rib, examine and sample as required.

6.3.7 Fifth step — examine the thorax

- Incise the pericardium and note the presence of any fluid or exudates.
- Palpate the lungs and heart, and then sever their dorsal and ventral attachments to the thorax keeping the heart attached to the lungs to form the "*pluck*".
- Inspect the epicardium and inner surfaces of the pericardium. Petechial and ecchymotic haemorrhages on the epicardium are a normal agonal change related to terminal asphyxia.
- Separate the heart from the pluck by severing the great veins, aorta and pulmonary artery well distal to the aortic and pulmonic valves.
- Examine the external myocardium then open the heart by incising vessels, valves and chambers in the direction of blood flow from the posterior vena cava to the aorta with heart valves being closely examined.
- Inspect the great veins, right atrium, right AV valves, moderator band, the right ventricle and its outflow tract, the pulmonary valve cusps and pulmonary artery
- Incise the pulmonary veins, left atrium, left ventricular outflow tract, through the aortic valves into the aorta and inspect.
- "bread slice" the heart to adequately examine the interventricular septum and myocardium before collecting a slice of left ventricular papillary muscle for histological examination if a sample is required
- Inspect the surfaces of and palpate both lungs. Estimate the percentage of lung affected by pneumonic lesions. Red discolouration alone does not mean that pneumonia is present. Normal lungs feel spongy, oedematous lungs feel rubbery, and pneumonic lung feels consolidated (like liver). Consolidated lung sinks in formalin.
- Incise the trachea through to primary and secondary divisions of bronchi.
- Collect lung and tracheal tissue for histological examination if required.

6.3.8 Sixth step — revisit the abdomen

- Hemisect both kidneys in situ (to assist later the location of adrenals) and inspect cut surfaces, calyxes and renal pelvis.

  Soft friable (pulpy) kidneys are not proof of enterotoxaemia (aka pulpy kidney) and are a common postmortem change especially in hot conditions. Enterotoxaemia is a disease of young (<12mo) unvaccinated cattle eating large amounts of high quality feed. These conditions are highly unlikely to occur in export cattle however enterotoxaemia should be suspected where an animal that has been healthy is found dead with a very full rumen.

- Collect a sample of kidney including both cortex and medulla for histology

- Locate adrenals by palpating tissues immediately anterior to kidneys. Excise and hemisect both adrenals and inspect cut surfaces.
- Blunt dissect the kidneys from the body wall to assist tracing of the attached ureters to the neck of the bladder.
- Palpate the udder to detect gross lesions
- Incise and inspect the four quarters of the udder, major milk sinuses and teats collecting samples for histology if necessary.
- Test a sample of urine for pH and ketones using a test strip. Incise the bladder wall to insert a dipstick, or aspirate a sample using a syringe and needle.
- Open the bladder and inspect the mucosa.
- Remove and inspect female and male genitalia as required.
- Estimate the age of the bovine or ovine foetus using the following formula:

  Gestational age in months = √[(crown-rump length in inches) x 2]

6.3.9 Seventh step — the head revisited

- Examine the eyes and excise if necessary.
- Section the masseter muscles, examine the mandibles, teeth and buccal mucosa
- If protocol dictates, remove the brain and pituitary gland. Advice on how to do this is given in other sections of the Handbook.

  Brain removal would normally only be performed if there was a history of nervous signs, or where the rumen contents were excessive and other findings were absent and so suggestive of enterotoxaemia.
- If only the brainstem is required, sample it via the foramen magnum using a modified spoon. The brainstem would be required in cases where there were no significant history or postmortem findings suggestive of cause of death. See other sections for method.
- Sever the ears to expose the middle ear. Do this last as the ears serve as occasional handles up to this point

6.3.10 Eighth step — examine the feet and limbs

- Examine soles, white lines and the interdigital space of all four feet for lesions. Lameness and swelling of the leg where no obvious skin or interdigital wound is apparent is almost always caused by microscopic punctures of the sole or white line, with subsequent bacterial infection.
- Palpate all limbs, especially joints, for swelling and crepitus and cut into these areas if found.
- Joints are sometimes most easily levered open from the medial aspect. The stifle joint is best opened by cutting the dorsal and medial patellar ligament and reflecting the patella laterally. Reflect the skin and place a bold cut in the medial joint capsule so that the joint can be levered open. Look for the presence of a cloudy change to the synovial fluid or reddening and thickening of synovial membranes.
- Incise major muscle masses of upper limbs and back and collect peripheral nerves if indicated by history or protocol.

- Cut down onto the diaphysis of the femur of the reflected hind leg and smash with hatchet or sledge hammer to examine bone marrow. Animals that are mobilising fat reserves will show a watery or gelatinous appearance to the marrow fat.

6.3.11 Ninth step — to the spinal column

- Cut between individual cervical, thoracic or lumbar vertebrae with a hatchet and light sledge hammer and dissect free with a knife. Remove the spinal cord from each vertebra by snipping nerve roots and meninges with scissors and pushing with the plunger from a 2mL syringe to extract the segment of the cord.

  Sampling need only occur if there are clinical signs referable to the spinal cord.

6.3.12 Tenth step — on completion

- Make written notes of necropsy findings while fresh in your mind.
- Download photographs onto computer and record case numbers in file name or extension.
- Complete the Necropsy/Dead Cattle Report form using **neat printed** writing so that forms can be easily read and photocopied.
- This Handbook provides advice on terminology and common errors of interpretation to help with report writing.

6.3.13 Final step — cleaning up and packaging

- Label sides of specimen containers with the voyage and case number in indelible ink.
- Wash equipment, apron and boots with sea water and rinse with fresh water and store equipment ready for the next use.
- At the end of the day wash the outside of specimen containers until clean, swab with sodium hypochlorite solution, dry, tighten lids and pack for return voyage.
- Pack containers of formalinised tissues for the return voyage by packing samples in small cardboard boxes. Use beer-carton-size boxes so that each is not too heavy for handling at unloading. Obtain boxes from chief steward.
- Place nasal swabs and fresh tissues into viral transport media and store frozen. Swabs from other tissues should also be frozen.
- After each box is filled, it should be sealed, numbered and listed on inventory for the return voyage.
- Use the checklist in Table 7.2 to make a list of the type and number of equipment to be replenished in the necropsy and diagnostic kits. Email or fax the stocktake to Greg Norman at Department of Agriculture Western Australia. E: greg.norman@agric.wa.gov.au; F: 08 9367 6248

7 Procedures and tips

7.1 How to sharpen a knife with a stone and steel

A razor sharp knife makes a necropsy quicker, easier and safer and results in better quality specimens. The mistakes that are commonly made in sharpening knives are uncontrolled bevel angles, failure to establish a new edge, and leaving the final edge too rough.

Under a microscope, the cutting edge of a knife can be seen to be a series of microserrations or microscopic “teeth”. Figure 7.1 is a photograph of the edge of a sharp knife magnified x 100. Through repeated use, the edge becomes progressively more roughened and chipped.

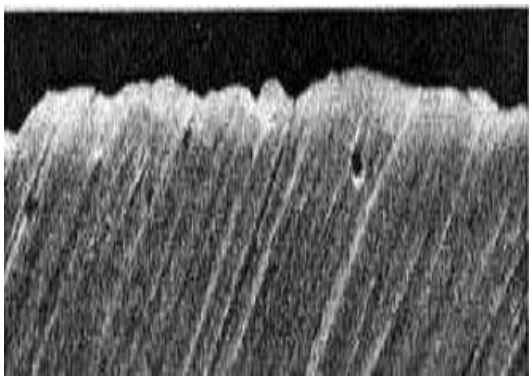


Figure 7.1: The edge of a sharp knife x 100

1. Use a large (15-20 cm long x 5-7.5 cm wide) flat silicon carbide or aluminium oxide sharpening stone (also known as a whet stone) (Figure 7.2). It should have a different coarseness on each side – one side should be fine (600) and the other medium (400) grit.

Figure7. 2: A sharpening stone

2. Keep the stone in a thick woolen sock for protection. The dampened sock works well as a non-slip mat during sharpening and protects the work surface.
3. Pick a bevel angle for your knife. Choose an angle of 10°-30° per side; shallower angles make a sharper edge that doesn't last as long, steep angles are more durable. Most skinning and boning knives for veterinary use have about a 15° edge angle. Select an edge angle that matches the type and extent of use the knife will receive. A 15^{o}, 20^{o}, or 30^{o} angle is achieved by raising the spine of the blade from horizontal by ¼, ⅓ and ½ of the blade width, respectively (Figure 7.3).

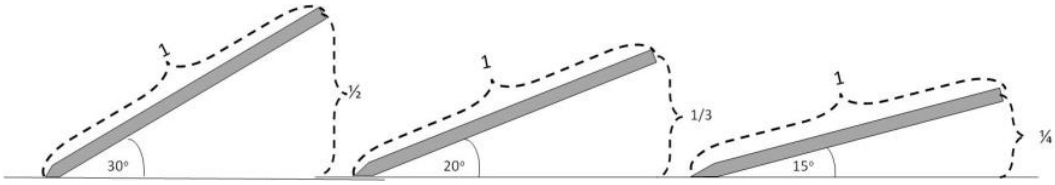


Figure 7.3: Knife edge angles of 15^o, 20^o and 30^o achieved by raising the back of the knife blade

4. Angle guides are available but are more suited to workshops. When sharpening knives in the field, the edge angle must be controlled by hand. Continuing practice will develop a well-formed perception of angles and the ability to maintain a constant edge angle during the different stages of sharpening.
5. Using a permanent ink felt-tipped pen, mark the bevel along the entire length of the blade. Examine this mark regularly while sharpening to ensure metal is being removed in the correct place at the correct angle and a new edge is being established.
6. Different stroke actions of the knife on a stone can be used ranging from circular to up and down to one-way. A common mistake is not holding the correct angle but instinctively raising the spine of the blade until it looks and feels like the edge is being worked. This creates larger edge angles and thicker bevels as time goes on and the knife blunts easily. The most important thing to keep in mind is to select a stroke action that allows a constant sharpening angle to be maintained.
7. The following one-way technique is recommended for beginners because it is easier to maintain a constant edge angle. It uses the whole length of the stone thereby reducing hollowing of the stone which can in time make it difficult to maintain a constant edge angle. With experience, two-way or circular strokes can be introduced to speed up the sharpening process.
8. Place the stone in front of you with the medium grit side upward and the long axis pointing away from you. Set and maintain the sharpening angle. Start sharpening the knife with it held perpendicular to the long axis of the stone and repeatedly push it away so that each time the spine is leading and the edge is trailing as shown in the diagram on the left in Figure 7.4. Use firm strokes.

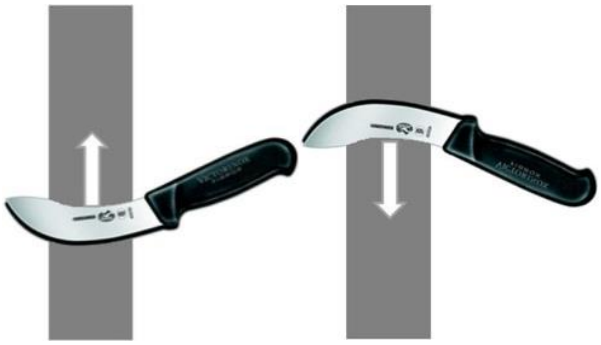


Figure 7.4: Sharpening the knife by dragging the edge

9. Continue grinding at this angle, concentrating on maintaining your selected sharpening angle, until your grind goes roughly half way through the steel (and a burr

is formed). Regularly check the erosion of the pen mark on the bevel to ensure that progress with establishing a new edge is occurring.

10. To sharpen the other side of the blade edge, turn the knife over and repeatedly draw the knife toward you, still with the spine leading and the edge trailing as shown in the diagram on the right in Figure 7.4. Alternate sharpening on one side and then the other.
11. Use firm strokes. Continue until you are satisfied that a new edge has been created evidenced by a burr along the entire edge (see more on burrs below).
12. Once the mark on the bevel has been removed and a new edge established, repeat the sharpening process on the fine grit side of the stone. Use the marker again as a guide to removing metal from the bevel in the correct place at the correct angle. Begin with firm strokes and then progressively lighten off the pressure. Continue until the entire edge is burred.
13. The easiest way to determine that enough metal has been removed is to sharpen until a "burr" is raised along the entire edge. A burr is the torn metal along the edge that steel naturally forms when one bevel is ground until it meets another. The burr is generally too small to see but can be felt by drawing the thumb over the edge. If the thumbprint catches then a burr is present. The burr forms on the edge on the opposite side of the bevel last sharpened. Finer stones produce smaller burrs.
14. The burr must be removed otherwise it will break off during cutting and the edge will quickly become blunt. Remove the burr by gently "slicing" the finer grit side of the stone. That is, still holding the blade at the same controlled angle, move the blade in the opposite direction to that used previously. This is shown in Figure 7.5. Do this on both sides of the new edge, applying gentle pressure initially then gradually lightening off the pressure. Removing metal always creates a burr. The lighter the pressure the smaller the burr.

Figure 7.5: Sharpening the knife by using a slicing action with the edge

15. When sharpening on the stone has been completed (as judged by the edge looking and feeling very sharp), stroke the new edge lightly on a fine or smooth steel to further reduce the burr to become the microserrations of the new edge. Do this by positioning the steel vertically with the end pressed into a flat stable surface. Holding the steel firmly in the vertical position, gently stroke the knife down while drawing it toward you; do one side of the steel then the other, concentrating on maintaining the

sharpening angle of previous stages. A front and side view of this procedure is shown in Figure 7.6.

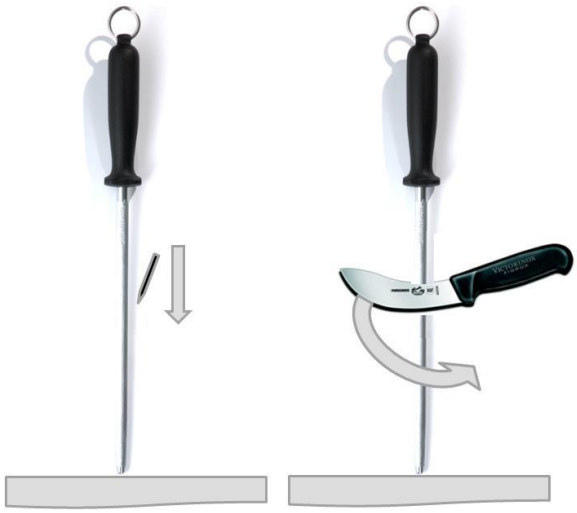


Figure 7.6: Holding the steel still and vertically to sharpen the knife

16. A further level of sharpness can be obtained by honing the edge on a strop made of leather or canvas glued to a hard, flat wooden base. Honing can be done first using a metal polishing paste (containing superfine metal abrading particles) applied to the strop and then honing on another stop without the paste. Honing causes the microserrations of the edge (which are the last remnants of the burr) to become short and tightly and evenly aligned. This gives the edge superior sharpness and durability.
17. Sharpening stones (with exception of Japanese water stones) work better without lubricant. The objective during sharpening is to remove metal. Lubricants work against this. Even oil stones don't need oil. Oil is messy. If you feel a lubricant is necessary, use water. If you feel an oily lubricant is necessary, use soapy water.
18. Accumulation of metal particles on the stone will reduce its abrasiveness over time. The particles can be removed by brushing the stone with a stiff brush and warm, soapy water.

Assessing sharpness

There are four ways to field test final sharpness.

1. Do a visual check for white lines and spots on the edge which are the reflected light from burrs, nicks or blunt areas that will need more work. Hold the edge vertically under good light over a dark background and use a magnifying glass if available. A blunt edge or an edge with burrs and nicks will reflect light. A razor sharp knife edge will not show "bright spots" when examined under a bright light.
2. By lightly stroking the thumb pad across the edge. A sharp edge can be felt catching on the fingerprint pattern. Stroke across the edge in both directions to ensure a burr is not being mistaken for a sharp edge.
3. Draw the edge over the barrel of a pen (or finger nail). If it glides smoothly it is sharp, if it catches, it needs more work.
4. By shaving slices off the edge of a suspended piece of newspaper. A sharp knife cuts the paper; a dull knife tears it.

Protecting your equipment

Sheath knives in a plastic scabbard to protect the edges; don't just keep them loose in a toolbox. Dry steels thoroughly after use to prevent rust. Store whetstones in a thick woolen sock to prevent dents and chips.

Choosing a knife and steel

When choosing knives, get a skinning knife for the rough work involved in dismembering the carcass and a boning knife for the finer dissection of viscera and tissues samples (Figure 7.7). Shorter knives with blades 12.5 to 15 cm are better – easier to sharpen, store, and less fatiguing on the wrist. They should have solid plastic handles so that they are easy to disinfect.

Choose a steel with a plastic handle, an "O" ring, a hand guard and with the steel section being 25 to 30 cm long. Smooth steels are fine if a good job has been done with the whetstone. They are used to realign microserrations bent during cutting. Fine to medium grooved steels are good for all round use. Used gently, they realign bent microserrations; used forcefully they remove metal and may sharpen a dull edge but may set back a honed edge. Coarsely grooved and diamond steels can remove a lot of metal and wear out a blade very quickly.

L **R**

Figure 7.7: A short, plastic handled skinning (L) and boning (R) knife

7.2 Taking necropsy photographs on cattle ships

7.2.1 Digital camera specifications

The following minimum specifications are desirable:

- 1-2 megapixel resolution (or higher)
    - Higher resolution photographs are generally better but also take up more memory. 1 to 2 MB JPEGs will generally be adequate.
- minimum 128 MB memory card and at least one spare card in case of mishap.
- robust and splash-proof

- Macro capacity (close up shots) is desirable but not essential

7.2.2 Photograph requirements

The photographic shots required are as follows:

1. Dead cattle in situ before they are relocated or dismembered **with** the **case number** on a small placard or the **NLIS tag number** captured in the photograph.
2. Each of the major body cavities (i.e. oral, thorax, abdomen) at end of display stage (see necropsy protocol) even if no lesions are evident.
3. Organs and tissues where there are gross changes suspected to be caused by disease

Where there are gross changes suspicious of disease, take initial photo(s) of the organ showing surrounding tissues for context, then take a close up showing the lesion(s) in more detail.

The camera can be protected in a zip lock plastic bag. Photographs are taken through the zip lock opening as required.

It is desirable to have someone other than the operator take the photographs during the necropsy – to save time.

7.2.3 Tips for good photographs of suspect lesions

- Remove blood to increase contrast.
- Use props to position the lesion e.g. drape the opened abomasum over a bucket to photograph an ulcer or ostertagia nodules, or raise the liver with a hidden specimen container or wad of paper to emphasise a thickened edge.
- Demonstrate size with a coin or key (rulers tend to be obtrusive)
- Minimise reflections from wet shiny surfaces by drying with a paper towel and having torch or port hole light directed so that any reflection is away from the photographic axis.
- Use a clean, dry, light-coloured background whenever possible

7.2.4 Saving and making copies of photographs

- Download the photographs from camera to laptop at the end of each day.
- For each photograph, rename the file to include the case number.
- At the end of the voyage, copy all the photographs onto the USB stick provided and send to Dr John Creeper at the Western Australian Department of Agriculture Animal Health Laboratory, South Perth. A CD or DVD is also fine.

Note: It is important to preserve the original photographs at their original resolution. If the photographs are to be emailed or used in publications, make a copy of the original and save under a different file name that still contains the case number. These copies can be made suitable for emailing by shrinking to 100 to 300 Kb after cropping and adjusting for brightness and contrast if necessary.

7.2.5 Privacy

Take care when distributing, publishing or showing photographs that privacy and confidentiality are protected.

7.3 How to age cattle by their teeth

Cattle have eight incisors, three pairs of premolars and three pairs of molars (Figure 7.8)

Figure 7.8: Skull of cow showing incisor, premolar and molar teeth

Table 7.1: Aging cattle from incisor and molar eruption

Age	Incisors	Molars
6 months		First permanent molars up
12 m	All calf teeth present	2nd permanent molars appear
15 -18 m	First permanent incisors appear	
18 m		2nd permanent molars up
18 -24 m	First permanent incisors in wear	
24 -30 m	2nd permanent incisors up	3rd permanent molars appear
30 m	3rd permanent incisors up	3rd permanent molars up
36 m	3rd permanent incisors in wear	
39 m	4th permanent incisors up	
42 m	4th permanent incisors in wear	

7.4 How to remove the whole intact brain using the longitudinal craniotomy

Longitudinal craniotomy involves splitting the skull (but not the brain) ventrally and dorsally along its longitudinal axis with a hatchet. The two halves are levered open from the front end to expose the intact brain. The hatchet is hit with a small sledge hammer for greater control and safety. Eye protection should be worn. It has the advantage of exposing the pituitary gland, nasal passages and nasopharynx. The procedure can be performed quickly, simply and safely under field conditions with minimal equipment. The method requires practice but once mastered the whole intact brain can be removed in less than one minute.

The **equipment required** includes a hatchet, small sledge hammer, boning knife, disposable rubber gloves and safety glasses.

The dissection process is as follows:

- Skin the ventral head and remove the tongue and soft tissues of the throat so as to expose the hard palate and ventral cranium. Turn the head over and cut the skin on the top of the head along the midline. Extend the cut deeply into the soft cartilage of the nose in the midline to split the nose. The split line is shown in Figure 7.8.
- With a hatchet, crack the dorsal skull along the length of the midline where the skin cut has been made. The aim is to crack the bone (cranium) surrounding the brain without damaging the brain but fully cut through the depth of the nose and jaw. Turn the head over. Using a hatchet, split the front of the bottom jaw, crack the cranium along the midline and split the hard palate and nose to full depth.
- With a knife, cut any soft tissue attachments that might prevent the two halves of the head being levered apart (using the two halves of the split nose). Grasp the two halves of the split nose and slowly prise and pull them apart as shown in Figure 7.8. More bone cracking will be required if the head won't come apart easily. If the cranium has been cracked sufficiently, the whole head can be levered open and the brain and pituitary gland exposed.

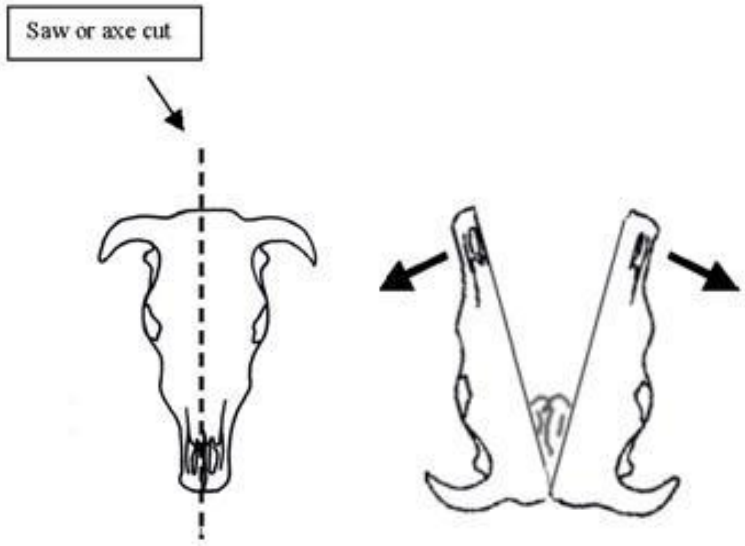


Figure 7.8: The splitting line and leverage points for a longitudinal craniotomy

- A boning knife (or scissors) is used to cut the nerve roots and dura mater (the white tough membrane that surrounds the brain). After removing the dura mater the brain can be rolled out from front to rear.
- Remove all of the dura mater reflection (*tentorium cerebelli*) that projects downwards to provide a transverse partition between the cerebral hemispheres and cerebellum. Failure to excise it may result in damage to critical anatomic sites in the brainstem when the brain is subsequently lifted from the cranial cavity.
- The hemisected pituitary gland is exposed at the base of the brain. Check the base of the cranium for abnormalities such as fractures, tumours or abscesses. It is easily removed if required.

- Cut the brain between the cerebral hemispheres to just open the ventricles. This will allow formalin to access the inside of the brain. Alternatively, the cerebrum can be cut transversely multiple times like a loaf of sliced bread but not full thickness so as to leave a 2-3 cm depth of tissue along the ventral brain to connect the slices. Immerse the brain and pituitary in 10% buffered formalin.

Common mistakes include cracking (cutting) too deeply into the bone around the brain, particularly the bone protecting the ventral brain, which can lead to damage of the ventral brain stem. Insufficient 'cracking' of the bones surrounding the brain, particularly the ventral cranium, can make it difficult to lever the cranium apart. One side of the nose breaks. Levering the head apart too quickly can tear the brain.

7.5 How to remove the brainstem with a modified spoon

The brain stem can be removed without opening the head using a 'prionics spoon', called such because they are used to collect samples for prionics or TSE testing. Spoons for sheep and cattle are different sizes.

The procedure is as follows:

- Remove the head and place it with the nose down. Clear fat and muscle from the occipital condyles to allow access to the foramen magnum and brain stem.
- Slide the prionics spoon between the occipital condyles and over the dorsal surface of the brain stem.
- Keep the tip of the spoon pointing dorsally until ¾ of the blade is past the occipital condyles. Then, push the blade ventrally and move the tip of the spoon from side to side to insure a proper cut.
- Once the brain stem is removed examine it to make sure a small section of the spinal cord, the obex and part of the medulla are present and fix in 10% buffered formalin as soon as possible.

Figure 7.9: Showing spoons and spoon placement

7.6 How to describe gross changes found at necropsy

A good description of your necropsy findings is very helpful to the pathologist examining and testing your samples. Photographs of lesions are a very useful addition to your written description.

Field investigators tend to describe gross findings by providing a specific diagnosis in the hope that it serves as both a description and provisional diagnosis. Examples include "*the lungs had pneumonia*" and "*the intestines had haemorrhagic enteritis*". This approach can be misleading and serves as a poor record. Describing and interpreting gross lesions is relatively simple with a little practice. Below are some guidelines.

Description

- Use plain, simple language.
- Do not record anything for normal organs and tissues unless a normal finding is unexpected.
- Use six of the seven senses – 1. sound, 2. sight, 3. smell, 4. touch, 5. feel and 6. common sense. Don't use the 7th sense, taste.
- Use a checklist of features. i.e. DA DE SSSSS CCCCP ("dadescp")

  Displacement - the abnormal location of an organ or tissues

  Adhesion – adjacent tissues stuck together due to inflammation

  Distribution – the spatial arrangement of lesions i.e. random, symmetrical, focal, multifocal, coalescing, miliary, diffuse, segmental

  Extent – the percentage of an organ affected

  Size – described as lesion dimensions in length or weight or size relative to a common object (golf ball or fist) or relative to another organ in a pair. Lesions can be uniform or non-uniform in size. Weight can be light or heavy and is often subjective even when weight is measured on scales.

  Shape – describe as circular, rectangular, triangular and so on. Borders are described as distinct, diffuse, irregular, serrated etc.

  Surface (including cut surface) – smooth, rough, ulcerated, dry, raised and so on

  Sound – what is heard when percussed or auscultated – crepitant (gas), sloshing (free fluid), knocking (solid)

  Smell – define the lesion by its odour i.e. sweet, foul, ammonia-like, cider-like, rotten egg like, acetone, odourless

  Colour – the complexion or tincture which distinguishes the lesion such as brown, red, gray, black, green; reddish black, whitish gray. Varieties of one colour are hues e.g. hues of red or green. Light and dark are not colours.

  Contour – surface irregularities e.g. raised, depressed or flat.

  Consistency (and texture) - Describes degree of density or viscosity of a lesion e.g. gas, fluid, solid.

  Content –Volume and nature of contents of hollow organs particularly bladder, gall bladder and reticulo-rumen; full, half full, empty; colour, smell, texture, particle size, foreign objects.

  pH – 1-14 of urine and reticulo-rumen contents

7.7 How to interpret gross changes found at necropsy

- ***Small lesions*** can be recent or slow growing; ***Large lesions*** mean long standing or fast growth.
- ***Non uniformity of size of multiple lesions*** means ongoing event or waves. ***Uniformity*** indicates recent lesions or single event.
- ***Coalescing lesions*** indicate long standing and continued growth.
- ***Miliary lesions*** indicate showering.
- ***Patterns, segmental and symmetrical lesions*** are often outlines of vascular bed or units of tissue architecture.
- ***Raised lesions*** are due to injection of fluid, cells or stroma.
- ***Depressed lesions*** are necrosis, atrophy or fibrosis.
- ***Flat lesions*** are congenital or recent.
- ***Amorphous texture and consistency*** of lesions are pus, exudate or necrosis.
- ***Solid texture and consistency*** of lesions are usually live tissues except for tubercles and calcified granulomas.
- ***Hardness and grittiness*** are bone, cartilage or calcification.
- ***Firmness*** occurs in stroma-rich, fluid-poor tissues.
- ***Softness*** occurs in stroma-poor, fluid-rich tissues.
- ***Gas*** is from lungs, aspirating wounds or bacterial production.
- ***Dark tissues*** have high pigment to tissue ratio i.e. muscle, spleen, liver.
- ***Light coloured tissues*** have a high fat to tissue ratio i.e. brain or a low pigment to tissue ratio i.e. scar tissue or lung.
- ***Pigments*** are haemoglobin, myoglobin, bile and sometimes bacterial products such as H_2S or fungal fruiting bodies.
- ***Green*** is usually bile, green-black is bile or bacterial H_2S and are limited to serosal or capsular surfaces.
- ***Black tissue*** is from melanin. Black faeces (melaena) are from digested blood.
- ***Blue black*** can be intense haemorrhage.
- ***White to grey to yellow*** is lack of blood or accumulation of leucocytes.
- ***Red to reddish black*** is blood or haemorrhage. Congestion is diffuse (widespread) and poorly demarcated.
- ***Necrosis*** is pale and associated white-yellow exudates will cause raised surfaces. Blood can darken exudates.

7.8 Common diagnostic mistakes at necropsy

Rumenitis – Sloughing of the rumen mucosa is a normal postmortem change and is not evidence of rumenitis or excessive grain feeding.

Pneumonia – Discoloration of the lungs on its own is not a sign of pneumonia. Pneumonia should be diagnosed by feel. Normal lungs are soft and spongy even if discoloured by pooling of blood or congestion. Lungs with pneumonia feel consolidated like liver.

Enteritis – red to blue-black intestines containing bloody fluid is often a postmortem artifact and should not be diagnosed as haemorrhagic enteritis unless accompanied by necrosis, oedema, ulceration or fibrin.

Blood poisoning – petechial or ecchymotic haemorrhages affecting the heart are a normal post mortem finding in cattle particularly in cattle that have been euthanased. Haemorrhages elsewhere in the body are more likely to be associated with septicaemia or a clotting defect.

Hyperthermia – core body temperature normally elevates considerably after death in large, fat, hairy or otherwise well insulated cattle. However it usually takes a few hours before the temperatures approach the levels expected in heat stroke (≥43C).

Bloat – well conditioned animals can bloat quickly after death and develop signs resembling true bloat such as congestion of the head and neck and an oesophageal bloat line if post mortem bloating occurs before blood coagulates.

Enterotoxaemia/pulpy kidney – Enterotoxaemia (aka pulpy kidney) is unlikely to occur in export cattle. Pale mushy, pulpy kidneys are a normal post mortem change more pronounced in hot conditions. Enterotoxaemia is difficult to diagnose in cattle but if suspected the brain should be sampled for histology and urine tested for presence of glucose.

7.9 Veterinary necropsy equipment checklist

Table 7.2 provides a list of equipment considered important for performing necropsies under the protocols described in this Handbook. Note that specific items may be the responsibility of the ship, the AQIS Accredited Veterinarian (AAV) or may be provided by the current project (W.LIV.0252).

Equipment will be loaded onto the ship by Mr Greg Norman (DAFWA), and packaged samples will be unloaded by Greg when the ship returns to an Australian port. At the end of the voyage, the AAV should complete a stocktake form and email it to Greg Norman, along with an indication of the number of necropsies performed and where samples are stored on the vessel (**greg.norman@agric.wa.gov.au**).

Table 7.2: A checklist of necropsy equipment and their kits for carriage aboard cattle ships

VETERINARY NECROPSY EQUIPMENT KITS FOR CATTLE SHIPS			
Equipment kits - *Responsibility for supply*	**Project**	**AAV***	**Ship**
Protective equipment kit			
1. Boots - rubber boots		✓	
2. Gloves – disposable, nitrile (medium – other sizes on request)	✓		
3. Knee pads - rubber	✓		
4. Glasses – safety x2	✓		
5. Overalls – polyester cotton, short sleeve x3		✓	
Euthanasia kit			
1. Captive bolt, cartridges and cleaning kit			✓
Restraint kit			
1. Halter - rope, nylon			✓
2. Nose grips			✓
3. Stick - polypipe or bamboo 100cm			✓

Table 7.2 continued next page

Table 7.2 continued

Equipment kits - Responsibility for supply	Project	AAV*	Ship
Dissection kit			
1. Scalpel blade handles – x2	✓		
2. Scalpel blades – scalpel No. 22, x1 box	✓		
3. Forceps – toothed, 15cm, x1	✓		
4. Hammers – small sledge, fiberglass handle, 4lb, x1	✓		
5. Hatchet – heavy duty, fiberglass handle, 2lb, x1	✓		
6. Knife - 20cm skinning 2cm wide curved blade	✓	✓	
7. Knife - l5cm boning knife pointed straight	✓	✓	
8. Knife scabbard and chain belt	✓	✓	
9. Sharpening stone – combination fine-medium grit x1	✓		
10. Sharpening steel - 30cm butcher's x1	✓		
11. Pig puller – for moving animal carcasses	✓		
12. Rib cutters (pruning shears) x1	✓		
13. Pull through kitchen sharpener	✓		
Sample collection kit			
1. Plastic screw top jars - medium 250mL, polypropylene, sterile x30	✓		
2. Plastic screwtop jars – 2L x30	✓		
3. Plastic bags - ziplock	✓		
4. Scissors - Mayo straight 18cm	✓		
5. Plastic clotted blood tubes retraction tubes x100	✓		
6. Plastic serum storage tubes 5mL x200. FREEZE AFTER SAMPLING	✓		
7. Syringes – box 20mL x2	✓		
8. Needles – box 100 18G x1	✓		
9. Viral transport media – 50 tubes of 5m. Store frozen, re-freeze after sampling	✓		
10. Sterile swabs (wooden shaft) – x100	✓		
11. Formalin – 20L container, tap attached. (add water to make 10% buffered formalin). Store in air conditioning	✓		
12. Formalin – 2 x 5L containers of concentrate, Store in air conditioning	✓		
13. Spare tap for formalin container	✓		
14. Foam racks x 2	✓		

Table 7.2 continued next page

Table 7.2 continued

Equipment kits - Responsibility for supply	Project	AAV*	Ship
Diagnostic kit			
1. Stethoscope x1		✓	
2. Test strips - urine, blood glucose, nitrate and cyanide test, pH	✓		
3. Rectal thermometer digital x2	✓		
4. Deep probe digital thermometer, up to 50^{o}C, for detecting deep core temperature, Encase in ziplock bag, x2	✓		
Packaging and dispatch kit			
1. Tape – electrical sealing x3rolls	✓		
1. Tape – packing x3rolls	✓		
2. Pencil – black lead	✓		
3. Pens - black biro	✓		
4. Cardboard boxes – flatpacks x 5	✓		
5. Small esky with ice brick for taking below decks x 2. FREEZER SPACE REQUIRED	✓		
Cleaning and disinfection kit			
1. Brush - scrubbing x1	✓		
2. Screw driver - for cleaning out grooves in soles of boots	✓		
3. Buckets – plastic, 22L with handles and lids & lid cutting boardsx2	✓		
4. Pegboard hooks - assorted	✓		
5. Bucket apron organiser for 20L bucket	✓		
6. 1L measuring jug with hook handle	✓		
7. Container - sharps disposal	✓		
8. Detachable tray for holding used and dirty equipment	✓		

Table 7.2 continued next page

Table 7.2 continued

Equipment kits - Responsibility for supply	Project	AAV*	Ship
Recording and reporting kit			
1. Camera – digital, waterproof		✓	
2. Camera memory cards – spares x2		✓	
3. Camera charger and spare batteries		✓	
4. Forms – Necropsy/Dead Cattle Report x 30	✓		
5. Forms – Daily health report x 30	✓		
6. Stocktake of equipment x2. Fill out after voyage and email to **greg.norman@agric.wa.gov.au**	✓		
7. Data collection protocols x2	✓		
8. Veterinary handbook x2	✓		
9. Voice recorder - digital for recording your findings - OPTIONAL		✓	
10. Permanent ink marking pens – black x6	✓		
11. 1 Gigabyte USB drive (contains project documents & can be used to store digital photographs/forms etc)	✓		

7.10 Sourcing and managing equipment

The necropsy equipment provided by the project will generally be loaded into two 22L plastic buckets (with tight fitting lids and strong handles).

Other equipment, including containers, formalin, transport media, forms and bulk items, will be packaged into boxes or plastic containers. Items that need to be stored in air conditioning will be packaged in one container.

All necropsy equipment can be carried in one or two buckets and possibly an over-the-shoulder satchel or backpack (useful for forms, camera etc). The following suggestion is based on the use of two buckets for carrying equipment.

Table 7.3: List of contents of buckets 1 and 2 and the satchel for carrying necropsy equipment to and from the necropsy site.

Bucket 1	Bucket 2	Shoulder satchel
• Forceps	• Bucket tool organiser	• Camera
• Glove packets	• Bucket tool organiser	• Clip board
• Hatchet	• Deep probe digital thermometer	• Forms – Necropsy/Dead Cattle Report
• Peg board hooks - assorted	• Detergent	• Forms – Daily Health Report
• Plastic measuring jug	• Formalin containers 2 x 2L	• Notebook
• Rib cutters	• Needles	• Pens
• Safety glasses	• Viral transport media	• Plastic zip lock bags
• Scissors	• Plastic bags	• Ruler
• Scrubbing brush	• Plastic screw top jars	• Veterinary handbook
• Sharpening steel	• Blood/serum tubes	
• Sharpening stone	• Rectal thermometer digital	
• Skinning and boning knives in scabbard	• Sterile swabs	
• Small sledge hammer	• Syringes	
	• Urine test strips	

The equipment and bucket approach has been modified from the Jubb Bucket System (JBS) developed by Dr Tristan Jubb. More information about the JBS can be found at www.livestockhealthsystems.com.au and complete systems can be purchased through this website. It is recognized that AAVs may have their own systems for carrying and maintaining necropsy equipment, but the following approach is suggested as a useful approach that is well suited to the task of carrying equipment around a vessel.

7.12a ***7.12b***

Figures 7.12 a and b: The JBS showing buckets 1 and 2 and their contents as they would be set up at the necropsy site. On completion and after cleanup the contents are put in the buckets and the buckets sealed with a lid.

Bucket 1 can be set up with pegboard hooks to hang items on the outside while water and soap/detergent can be added to the inside of the bucket. Bucket 2 has the organizer with small items pre-loaded and sample containers inside. Bucket lids can form ground trays as required. A lidded bucket can also serve as a seat while performing the necropsy.

8 Data collection for W.LIV.0252

W.LIV.0252 is a four year research project collecting data and samples from export voyages to determine cause of death in cattle exported from Australia to long haul destinations. This Handbook describes protocols for necropsies and sample collection performed as part of the project. There are two forms that need to be filled in by AAVs during the voyage as part of this project. Completed forms and digital photos (stored on the provided USB drive) and necropsy samples, can be packaged all together at the end of the voyage and stored (along with completed AQIS import forms) on the vessel. Mr Greg Norman (DAFWA) will unload the packages when the vessel returns to an Australian port.

The two forms are reproduced at the end of this Handbook and multiple copies of each is provided in the equipment loaded onto each vessel:

- Daily health report
    - to be filled in on each day of the voyage
- Necropsy/dead cattle report
    - To be filled in for each cattle death (including deaths where a necropsy was not performed)

Use simple codes to link samples & reports

It is important to use a simple **coding system** on sample containers and data collection forms (i.e. necropsy/dead cattle reports). The suggested approach is a code containing the voyage number and the case number. For example the 17th necropsy on voyage 26 might be coded 26.17. This code is then recorded on all sample containers. The necropsy/dead cattle report captures the voyage number, case number and all other essential case information.

Other reports and sources of data

Existing 'outputs' of data include (i) Daily Voyage Reports and (ii) End-of-Voyage Reports, contents of which are listed in Annex 1. Accredited AQIS veterinarians (AAV) are legally obligated to submit Daily Voyage Reports and End of Voyage Reports containing specified information.

The sources of data currently contributing to the Voyage Reports include:

- The **load plan** which contains numerical, descriptive and diagrammatic information on the number, type and location of cattle on board.
- The **Notice of Intention** which includes the name and address of the exporter and consignee, the intended ports of embarkation and discharge, the intended ship, date of departure, the name of the AAV, and species, classes, breeds, ages and quantity.
- **Pocket book records** of treatments, morbidity and mortality maintained **by individual stockmen** for the decks of cattle under their care
- **Pocket book records of the head stockman** who maintains summary data collated from the records of the stockmen
- Temperature and humidity **data recorded by a ship's officer**
- Fodder and water consumption **data recorded by a ship's officer**
- **Veterinary dispensary records** maintained by a ship's officer controlling medicine stocks
- Sea conditions and voyage progress recorded in **Master's log**

The **load plan** provides the important **denominator data** for epidemiological analyses. An example schematic layout of pens which forms part of a load plan is shown in Section 8.2. Figure 8.1 outlines the existing flow of data from the above mentioned sources to the voyage reports.

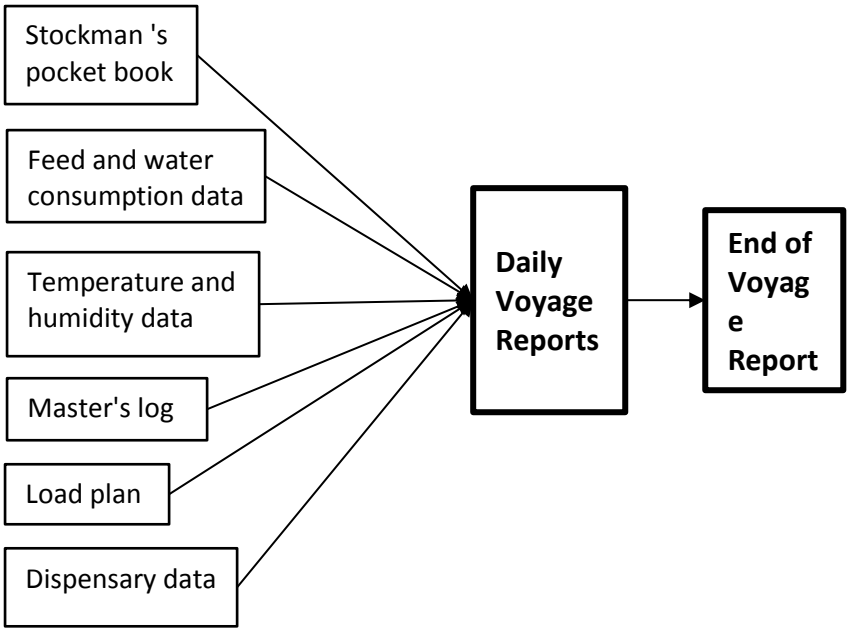


Figure 8.1: Existing data collection sources and flow of data for current voyage reports

The Daily Health Report and the Dead Cattle/Necropsy Report are intended to provide information that can be used as inputs into the Daily Voyage Report. This ensures that data and information collected as a result of the systems developed for this project, can be used immediately to provide input into the Daily Voyage Reports as well as accompanying samples back to Australia for analysis and reporting,

Figure 8.2 shows the proposed flow of data which incorporates the use of the Daily Health Report (completed each day as part of the W.LIV.0252 protocol) as a way for the AAV to provide input into the daily voyage reports and the end of voyage report.

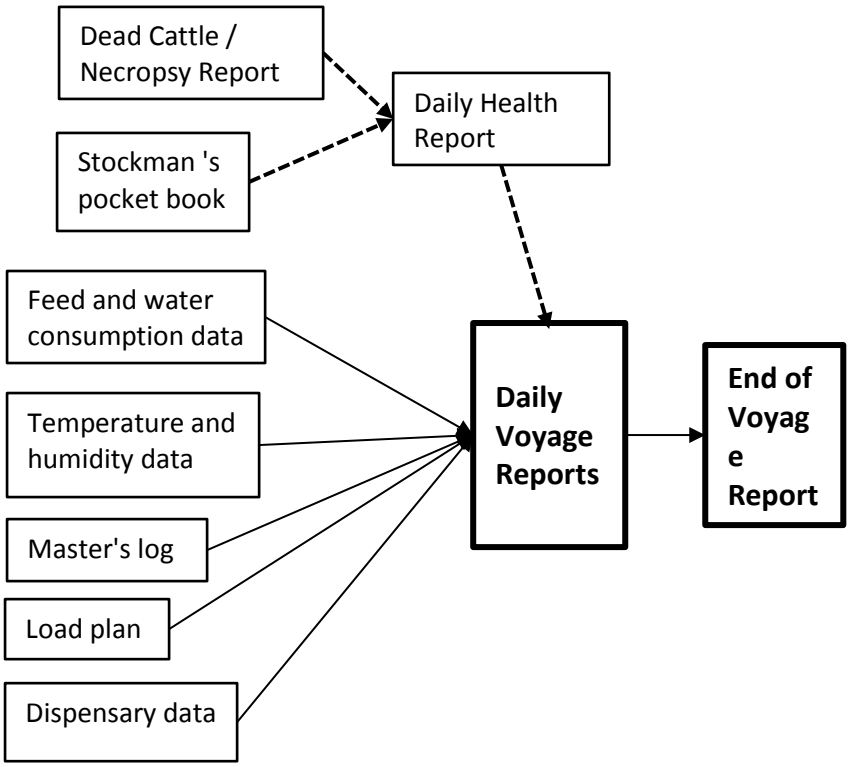


Figure 8.2: Data flow diagram showing extra data sources to be used in project W.LIV.0252

8.1 Content of daily and end-of-voyage reports

Daily voyage reporting requirements include:

- Temperature and humidity on board the vessel
- Wet bulb readings
- Deck or cargo hold conditions
- General conditions
- Respiratory rate and character of the livestock
- Whether and to what extent the livestock show heat stress
- Feed and water consumption of the livestock
- Hospital pen report
- Mortality rates
- Number of livestock that gave birth and estimated stage of pregnancy at time of giving birth for each birth
- Any other relevant matter

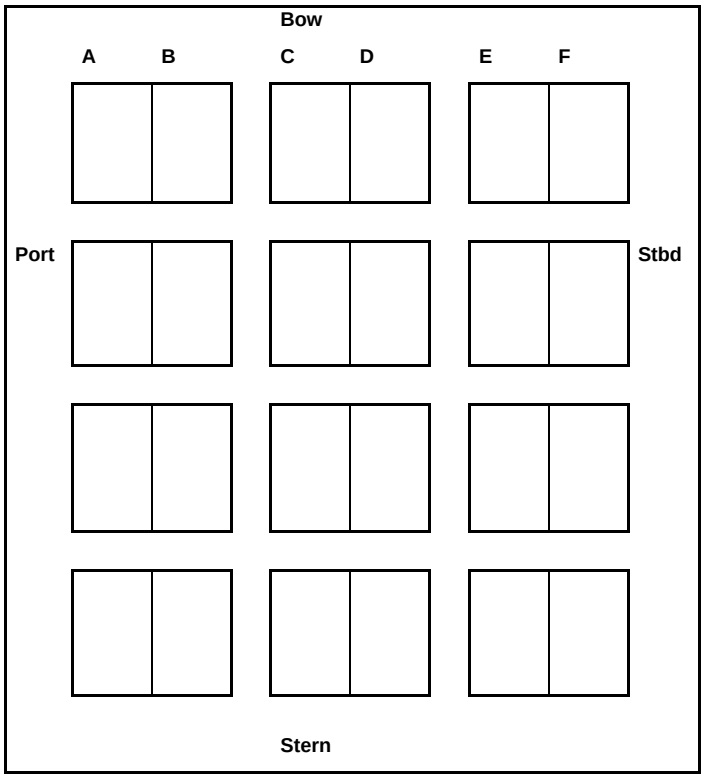
End-of-voyage report requirements include:

- Name of the exporter
- Month and year in which the loading of the livestock was completed
- Port or ports at which the loading took place
- Port or ports at which the livestock were discharged
- Month and year in which the livestock were discharged at each port

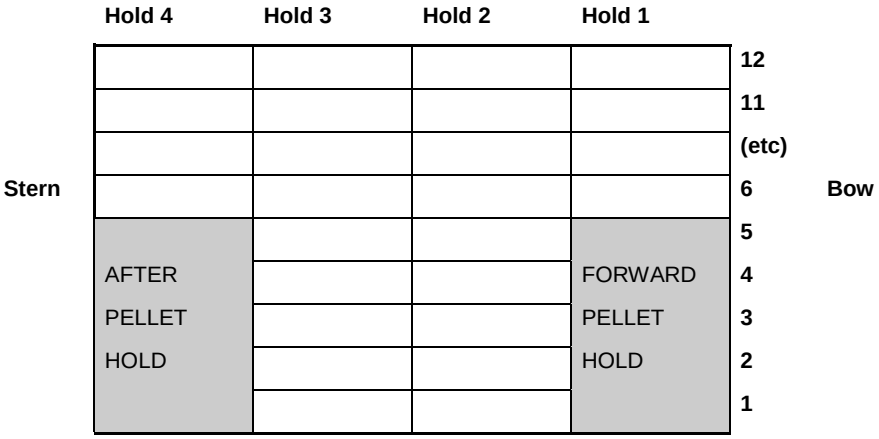
- Duration of the voyage
- Type or types of livestock
- Number of each type of livestock loaded
- Total mortality for each type of livestock
- Percentage mortality for each type of livestock
- Health and welfare of the livestock on the voyage
- Number of live-stock that gave birth and summary information in relation to the estimated stage of pregnancy at the time of birth for those births
- Any treatment given to the livestock during the voyage
- Anything else relevant to the livestock during the voyage

8.2 Example schematic layout of pens which forms part of load plan

Floor plan



Side view



Deck 1 cement

Deck 2 –5 steel mesh over wood

Deck 6 cement Deck 12 sheep deck = wood

Deck 7 steel mesh (broad) over steel

Deck 8 steel mesh over steel

Deck 9 – 11 non-slip (rough particles in bitumen) over steel

8.3 Necropsy/dead cattle report

(to be completed for all dead cattle including cattle not necropsied)

SHIP: _____ DATE: _____

VOYAGE NUMBER: _____DAY OF VOYAGE: _____

Location & Deck Washing:

Hold: ____ Deck: _____ Lane: ____ Pen: ____ (Usual location)

Died in Hospital Pen: Y / N

Date when deck was last washed: _____

Comments:_____ **Animal characteristics:**

Case number: _____

ID - Eartag: _____ ID - other: _____

Age (months): _____ Sex: M / F

Type: Taurus / Indicus / Cross Breed:_____

Weight: _____kg Condition Score (1 emaciated - 5 fat): _____

Other:_____

Syndrome/Clinical signs displayed before death:_____

_____

_____

Treatments:_____

Estimated time between death and necropsy: _____hours

Predisposing risk factors or events (circle/cross-out):

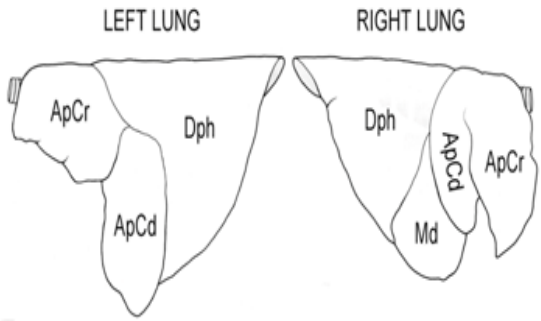
Animal factors: Age / Breed / Weight / Condition score / Size (eg compared to pen mates) / Hair coat length / Pregnancy / Lactation / Temperament / Other_____

Management Factors: Pen stocking rate / Access to feed/water / Water quality/quantity / Other:_____

Environmental Factors: Hold conditions / Weather / Wind direction / Air pollution (eg pellet dust) / Floor surfaces / Other:_____

Necropsy findings: Core body temp: ____°C

Lung: Discoloured _____%, Consolidated _____%



Draw lines to show location of consolidation or other pathology.

Mark sites where samples were taken (X for DNA media; F for formalin).

Lobes: Right Apical (cranial

Description of gross necropsy findings: _____

_____

_____

_____

Necropsy Samples Collected (circle/cross-out):

- Swab in viral transport media
  Nasal Faecal Lung-normal Lung-affected

  Other (describe): _____
- Formalin fixed tissue
  - *Targeted protocol - Samples to be taken from ALL animals*:
    Lung (normal & affected), Trachea (just proximal to bifurcation),

    Heart, Liver, Kidney, Ileo-caecal junction, Ventral rumen (wall & pillar)

  - *Targeted protocol - Additional samples for specific diseases/conditions (see Handbook):*
    _____
  - *Comprehensive protocol - ALL tissues listed above plus:*
    Skeletal muscle, Spleen, Adrenal gland, Mesenteric lymph node, Brainstem and spinal cord at C1 (use Prionics spoon), Pancreas, Reticulum, Abomasum, Large Intestine, Gall bladder,

Tentative Diagnosis:_____

_____

8.4 Daily health report

Ship:_____ Date:_____ Voyage Day:_____ Veterinarian:_____

Syndrome	Number of cases	Severity	Location	Breed	Class	Treated	Deaths or euth	Origin
	1=sporadic, 2=multiple pens, few per pen, 3=many pens or many per pen	1=mild, 2=moderate, 3=severe	Record affected locations (deck, hold, side)	1=Bos taurus, 2=Bos indicus, 3=Cross bred	1=steer, 2=heifer, 3=bull, 4=cow, 5=other	Tick if animals were treated	Tick if deaths/euth & number post-mortemed	Origin or line of affected cattle
Nasal discharge								
Respiratory Distress								
Lameness or injury								
Diarrhoea								
Ocular discharge								
Alopecia								
Ill thrift								
Abdominal Distension								
Knuckling								
Nervous Disease								
Prolonged Recumbency								
Straining								
Other								

9 Glossary of Scientific Terms

Within the context of this handbook, the intention of this glossary is to provide a better understanding for those readers who may not have a background of training in pathology, such as is generally provided in current veterinary degree courses.

Abdomen - The body between the chest and the pelvis

Abdominal - pertaining to the abdomen

Acidosis - An illness caused by accumulation of acid or depletion of the body's alkaline reserve

Abomasum - the fourth stomach compartment – equivalent to the stomach of single stomached creatures

Abscess - localised collection of pus in a cavity formed by tissue degeneration

Acute - severe, sharp, usually short term

Alimentary - Tract or canal; is all organs through which food passes

Alopecia - Absence of hair from skin where hair normally grows

Arthritis - inflammation of a joint

Asphyxia - lack of respiratory oxygen at lung or cellular level

Atrophy - decrease in the normal size of an organ or tissue

Auscultation - listening for sounds produced within the body – maybe with a stethoscope

Ballottement - method of feeling for a floating object within the body

Bilateral - affecting both sides or both organs

Brainstem - stemlike part of brain connecting it to the spinal cord

Bronchus - one of the larger passages conveying air within the right and left lung, the plural is bronchi

Caecum - a blind sac between the small and large intestine

Cellulitis - a diffuse inflammatory process within solid tissue

Chronic - persisting for a long time; usually one week minimum

Colon - the first, mostly coiled, part of the large intestine

Congestion - abnormal accumulation of blood.

Conjunctiva - the membrane covering the inside of the eyelids and white part of the eyeball

Conjunctivitis - inflammation of the conjunctiva

Contusion - bruising – injury to tissues without breaking the skin

Cornea - the clear see through part at the front of the eyeball

Cyanotic - mucous membranes with bluish hue due to presence of under-oxidised haemoglobin in the circulation

Decubitis - means lying down – decubitis ulcers are the result of lying down

Diagnostic - pertaining to making a diagnosis, or providing diagnosis

Diaphragm - the musculomembranous partition between the chest and belly cavities

Diarrhoea - Rapid movement of faecal matter through the intestine resulting in poor absorption of water, nutritive elements and electrolytes

Discrete - made up of separate parts, e.g. lesions that do not blend

Dyspnoea - Difficult breathing from any cause

Epithelium - a cellular covering of internal and external body surfaces

Embolisation - blockage of a blood vessel (usually artery) by a clot or other substance

Excoriation - superficial traumatic abrasions and scratches that remove some skin surface

Exudate - fluid and debris that has escaped from blood vessels and is deposited in tissues

Faeces - body waste discharged from the intestine via the anus

Fascia - bands or sheets of fibrous tissue under the skin or investing muscles or organs

Focal - limited to a small area or volume

Foreign body - plant or mineral matter within organs or tissues

Gastrocnemius - Muscle behind the tibia – extensor tendon joined to the hock

Gastrointestinal - Pertaining to stomach and intestines

Hypocalcaemia - low blood calcium level

Hypomagnesaemia - low blood magnesium level

Hypoxia - diminished availability of oxygen to the body tissues

Ileum - the terminal portion of the small intestine

Inappetance - loss of appetite

Infection - Invasion by and multiplication of microorganisms (bacteria, viruses, parasites, etc.) within body tissues

Inflammation - a localised protective response to injury or destruction of tissue – it is an essential part of the healing process

Inflammatory - pertaining to or emanating from inflammation

Infusion - controlled injection of a therapeutic solution into a vein

Interdigital - between the toes or fingers

Intestines - alimentary tract extending from the abomasum to the anus

Intramuscular - into the muscle

Intravenous - into a vein

Intussusception - intestine folding and running into itself

Keratitis - inflammation of the cornea, the clear front (window)of the eyeball

Keratoconjunctivitis - inflammation of the cornea and conjunctiva concurrently

Lacrimation - the act of shedding tears

Laminitis - inflammation and damage of the laminae inside the hoof

Lesion - any pathological discontinuity of tissue or loss of function

Lumbar - the back from last rib to pelvis

Macerating - softening of a solid by soaking

Macrocyclic lactones – a group of anthelmintics

Meningitis - inflammation of the meninges (the covering membrane of the brain)

Mucociliary - mechanism by which matter is commonly removed from the trachea

Mucosa - mucous membrane

Mucous membrane - membrane, covered by epithelium, and lining many tubular organs

Nares - the openings of the nasal cavity (nostrils)

Necropsy - also autopsy - examination of the body after death with the view to determine the cause

Necrosis - the death of cells within the living animal and enzymic tissue degradation

Necrotic - pertaining to necrosis

Ocular - pertaining to the eye

Oesophageal - Pertaining to the oesophagus

Oesophagus - Muscular tube connecting the pharynx to the stomachs – the gullet

Omasum - the third prestomach. Nicked named “the bible” because of its internal “leaves”

Osmosis - passage of a pure solvent from a solution of lesser to one of greater concentration across a semi permeable membrane

Osmotic - pertaining to osmosis

Parenteral - by injection

Pathogen - any disease producing agent - bacteria, viruses, parasites, etc.

Pathological - a change in the body as a result of, or causing, disease

Peritonitis - inflammation of the serous covering of organs within it, and lining of the belly cavity

Pharyngeal - pertaining to the pharynx

Pharynx - the throat where it is common to both the respiratory and alimentary systems

Phytobezoar - aggregation of plant material forming a foreign body in abomasum or intestine

Pleura - serous membrane covering the lungs and lining the chest cavity

Pleural effusion - excess of normal (lubrication) fluid produced by the pleura

Pleurisy (pleuritis) - inflammation of the pleura

Polioencephalomalacia - softening of the outer grey matter of the brain

Post mortem - means after death. PM examination may include necropsy/autopsy

Purulent - containing or forming pus

Recumbent - lying down and unable to rise

Reflux - a backward or return flow

Respiratory - Pertaining to respiration, i.e. to breathing and oxygenation

Reticulum - second prestomach. Honeycomb appearance internally

Rhinitis - inflammation of the mucous membrane (lining) of the nose

Rhinotracheitis - inflammation of the mucous membrane of the nose and trachea

Rumen - the first and largest prestomach of cattle and other ruminant animals

Rumen flora - the bacteria and protozoa present in the rumen and important for the digestive process

Septicaemia - systemic disease associated with bacteria and/or their toxins

Serous - thin and watery like serum – produces serum-like exudate

Serum - the clear portion of body fluids after removal of solids – e.g. blood serum

Solute - a substance that is dissolved in liquid to form a solution

Spinal cord - Nervous tissue running from the brain right through the vertebrae

Sternebrae – 7 sternebrae form the sternum, good for bone marrow samples

Subcutaneous - under the skin only

Syndrome - a combination of clinical signs that indicate a particular disease/condition

Therapeutic – pertaining to treatment

Therapy - treatment

Thoracic - pertaining to the thorax, the chest

Thorax - the chest

Toxaemia - condition arising from bacterial or other toxins spreading via the bloodstream

Toxin - a poison – some are produced by certain plants, animals, bacteria, etc.

Trachea - the “wind pipe”

Tracheobronchial - pertaining to trachea and bronchi

Trauma - wound or injury, especially those produced by intentional or accidental external agents

Traumatic - Pertaining to, resulting from, or causing trauma

Trichobezoar - as for phytobezoar but of animal (usually hair) origin

Ulcer - a defect or cavitation of surface of the body or an organ

Unilateral - affecting one side or one organ

Urethra - Tubular passage through which urine passes from bladder to exterior

Vascularisation - formation of new blood vessels in tissues

Vertebrae - The bones that make up the vertebral column (back bone)

Volvulus - (plural volvuli) twisting of an abdominal organ resulting in obstruction and strangulation of its blood supply

Vulva - the female external genital organs