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Efficient detection of Caseous Lymphadenitis (CLA) Lesions in Sheep and Goats at Slaughter

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Abstract

The national prevalence and distribution of lesions of Caseous Lymphadenitis (CLA) on an individual carcase basis was recorded on 54,915 sheep and 48,577 goats at slaughter in five sheep and three goat abattoirs over 4 months. The national CLA prevalence in sheep was 7.7% and for goats 3.0%. A total of 843 sheep and 132 goats had multiple CLA lesions.

The most common carcase sites for CLA lesions in sheep in decreasing prevalence were pre-scapular (4.8%), pre-crural (1.8%) and Ischiatic (0.5%) lymph nodes. Prevalence in offal was 1.6% with lesions in mediastinal lymph nodes (0.7%) and lungs (0.8%) the main sites.

For goats, the most common carcase sites in decreasing prevalence were prescapular (2.1%) and pre-crural (0.4%). Prevalence in offal was 0.3% of carcases with lesions with mediastinal lymph nodes (0.1%) and lungs (0.1%) the main sites.

To provide a basis for demonstrating the equivalence of alternative inspection procedures with the Australian Standard 4696 the sensitivity of current inspection procedures for detecting CLA lesions is estimated to be 90%, resulting in a current non-detection rate of 86/10,000 sheep and 33/10,000 goat carcases nationally.

Ranking of inspection sites by cumulative inspection effectiveness are presented and used to design alternative procedures for quantitative validation.

Executive Summary

Industry-wide problems with Caseous Lymphadenitis (CLA) has been a major issue for the Australian sheep and goat industry for many decades accompanied by significant financial losses to producers. However, with the advent of vaccination and reduced sheep dipping for lice there has been a reduction in prevalence and current post-mortem inspection procedures might be outdated. Additionally, CLA is not a public health risk and palpation has been demonstrated to result in cross-contamination that may result in a poorer food safety outcome.

Despite these improvements in animal health extensive post-mortem inspection procedures remain for inspection of sheep and goats for CLA in Australia (Australian Standard 4696-Anon 2007) especially when compared to other countries.

The overall objective of this project is to provide evidence to support alternative inspection procedures of sheep/goats for CLA that rely less on manual palpation and are sparing on resources while ensuring suitability. Hence, the aims of this initial project were to:

- Define which lymph nodes/thoracic organs are the best indicators (sentinel sites) of the presence of CLA lesions in individual sheep/goats.
- Identify other lymph nodes/offal most likely to have lesions when an affected carcase is detected at primary inspection (of sentinel sites), i.e. most probable distribution in carcases with multiple lesions. (Indicator sites can then be used as a basis for reduced palpation of sheep/goat carcases).

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Ranking of inspection sites by cumulative inspection effectiveness are presented and used to design alternative procedures for quantitative validation.

To provide a basis for demonstrating the equivalence of alternative inspection procedures with the Australian Standard 4696 the sensitivity of current inspection procedures for detecting CLA lesions is estimated to be 90%, resulting in a current non-detection rate of 86/10,000 sheep and 33/10,000 goat carcases nationally.

These new baseline data on CLA prevalence and distribution of lesions within affected sheep and goat carcases provide the opportunity to assess the equivalence of alternative inspection procedures against outcomes resulting from the current procedures of Australian Standard 4696.

In view of the comprehensive data already collected on affected carcase and offal sites and the cumulative effectiveness inspecting various combinations of sites, it was decided that an in-plant validation trial would only duplicate the data already available.

On this basis, it was determined that a desktop validation of the effects of changed procedure, i.e. palpation versus visual only, should be conducted. Alternative procedures recommended are presented, namely:

- Reduce palpation from 11 sites to 4 sites.
- The lymph node sites with lowest contribution to the cumulative detection rate of CLA gross abnormalities which are the same for sheep and goats (i.e. internal iliac, lumbar and superficial inguinal), are recommended to change from palpate to observe.
- Bronchial / mediastinal LN and lungs are proposed to change from palpate to observe only when lungs are not retained for human consumption.
- A CLA detection in any one site would trigger a traditional (i.e. palpation) carcase inspection either on the slaughter line or on the retain rail.

The approach to demonstrating equivalence with AS4696 is based on the “alternative techniques procedure” used by the Australian Meat Regulators Group in which a procedure not listed in AS4696 is compared with the effectiveness of a current procedure i.e. validated quantitatively by extensive testing.

The desktop validation will estimate the effectiveness of proposed alternative procedures using data on the cumulative effectiveness of inspection sites in combination with the effects on sensitivity of the changed procedures. The estimated non-detection rates arising from changed procedures will be compared to current estimated non-detection rates to assess equivalence with AS4696.

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1 Background

Industry-wide problems with Caseous Lymphadenitis (CLA) has been a major issue for the Australian sheep and goat industry for many decades accompanied by significant financial losses to producers. However, with the advent of vaccination and reduced sheep dipping for lice there has been a reduction in prevalence (reviewed by Radostits et al 2007; Windsor 2011). The prevalence of infection in ewes culled for age in WA has fallen from over 50% in the 1980s to approximately 25% in the early 2000s, which is suggested to be due to vaccination and a cessation of compulsory dipping for lice during this period (Paton et al 2002).

Despite these improvements in animal health extensive post-mortem inspection procedures remain (Table 6) for inspection of sheep and goats for CLA in Australia (Anon 2007) especially when compared to other countries (seven sets of lymph nodes versus four sets in the US – John Langbridge pers. comm.).

The epidemiology and risk factors for infection are well characterised including age, gender, source of infection and management/behavioural factors contributing to infection (Radostits et al 2007; Windsor 2011). Lesion distribution varies between species reflecting different routes of infection; for sheep due to shearing, dipping and vaccination and for goats due to (head) injuries. Effective vaccination has been available since the 1980s; however, poor compliance with manufacturers recommended vaccination schedules is common, leading to inadequate protection (Paton et al 2003).

More recent data from routine abattoir surveillance of sheep was introduced in NSW in 2006 to monitor CLA prevalence. CLA was detected in 33% of 15,000 consignments between 2006 and 2011, with 3.9% of all sheep inspected having CLA lesions (NSW 2015) supporting the contention that prevalence has declined substantially because of on-farm interventions. This improvement is reflected for sheep and for lambs in data from the National Sheep Health Monitoring Program and Enhanced Abattoir Surveillance Program in South Australia (Animal Health Australia 2015; Matthews and Dickason 2015).

In sheep, prevalence of CLA increases with age (Paton et al 1988) and reaches a peak incidence in adults. In a companion, Australian study of unvaccinated sheep in 1986 the prevalence of infection at abattoir inspection was 3.4% for lambs and 54% for adult ewes (Batey 1986a). In another large study of mature slaughter sheep (n=2661) in Australia in 1991, carcase lymph node prevalence was found to be 26% and offal lesions were found in 10% of carcases (Middleton et al 1991). The combinations of multiple lesions in sheep (individual lymph nodes /offal) was not reported in these studies.

CLA has been extensively studied in goats. Hein and Cargill (1981) reported 7.4% of feral goats in SA with lesions, a result supported by Batey et al (1986b) who reported 7.8% affected in WA. Both studies reported specific distribution of carcase lymph node and offal lesions but not detailed sufficiently to identify sentinel lesion combinations to inform inspection revisions. These surveys reported 9.5% and 17% of affected goats had multiple lesions.

As with sheep, prevalence increases with age – with the prevalence at four years of age being as high as 22% (Radostits et al 2007).

A more recent survey of 14,815 goats at a southern Australian abattoir in 2011 found 3.5% of carcases with CLA lesions in prescapular (superficial cervical) lymph nodes. While lesions

were recorded at much lower rates at other lymph nodes, data were not recorded on an individual carcase basis suitable to address the main aim of this project, though they provide a useful guide (John Langbridge pers. comm.). As with sheep, these more recent data indicate a lower prevalence of affected animals at slaughter than work three decades ago.

It is widely noted that post-mortem inspection may lead to risk of cross-contamination of carcases with unseen microbial contamination during palpation incision, including potential foodborne hazards (EFSA 2013a,b). In recognition of this, inspection changes have been justified in the US (Walker et al 2000) and supporting evidence has been demonstrated in Australia (Jordan et al 2012).

In summary, there is opportunity to reduce inspection effort and being a "wholesome" (non-foodborne hazard) issue an alternative arrangement may be to manage detection and removal of lesions within establishment QA programs or excise sentinel lymph node combinations as an alternative option.

2 Project Objectives

The overall objective of this project is to provide evidence to support alternative inspection procedures of sheep/goats for CLA that rely less on manual palpation and are sparing on resources while ensuring suitability.

Hence, the aims of this initial project were to:

1. Define which lymph nodes/thoracic organs are the best indicators (sentinel sites) of the presence of CLA lesions in individual sheep/goats.
2. Identify other lymph nodes/offal most likely to have lesions when an affected carcase is detected at primary inspection (of sentinel sites), i.e. most probable distribution in carcases with multiple lesions. (Indicator sites can then be used as a basis for reduced palpation of sheep/goat carcases).

As foreshadowed in the Preliminary Research Proposal a separate validation trial for "alternative procedures" is required for Innovation Adoption and Uptake of "Development of an alternative method or arrangement to deal with CLA lesions in sheep and goat" (as specified in the ToR). This current project provides the Go/No Go step for such work.

In addition, this project does not address identifying farm-level or animal-level predictors (i.e. risk factors) of prevalence and severity of CLA in lines of sheep presented for slaughter because these have been extensively studied.

3 Methodology

3.1 Sampling framework considerations

Key determinants of the project design included:

- Capturing animal level CLA distribution data on carcases with multiple gross abnormalities. This resulted in development and use of a protocol in which all CLA abnormalities were recorded on an individual carcase basis (Appendix 1 – data collection sheet).

- Inspection procedures for CLA as described in AS4696 (Anon 2007) were followed (Table 6).
- Inspection of heads was not included in the study due to the variable practice of retaining them for human consumption and for logistical reasons i.e. heads are removed at an early stage of carcase dressing and not retained in association with the carcase.
- Representative of industry to capture regional variability to cover the requirements of a national standard. This resulted in the participation of major abattoirs servicing the major sheep and goat production regions in Australia.
- Data on both sheep and goats was collected to capture variation in distribution of lesions due to differences in routes of infection.
- Data was collection over 4-6 months at each abattoir.
- To determine the distribution of lesions within affected carcases the aim was for a minimum of 100-150 carcases/establishment with multiple lesions to be recorded.
- For logistical reasons, data were collected over short periods (e.g. ½ hour) each day for 3 to 4 months as required to reach the target number of animals with multiple lesions.
- Lambs were excluded from sampling.
- The survey did not attempt to determine the prevalence of affected lots or prevalence within affected lots.

To underpin the rigour of national data collected a Standardisation Workshop was conducted for key personnel from collaborating abattoirs (Table 1). Participants were primarily senior QA and production managers with Cert IV meat inspection qualifications. The workshop enabled industry experience to be captured in the methodology, take into account logistical considerations and validate the data collection recording sheet by all participants (Appendix 1).

Table 1: Participating companies

Company	Abattoir location
Western Meat Exporters	Charleville
Fletcher International	Albany
Wodonga Abattoirs	Wodonga
Fletcher	Dubbo
Herd	Corio
Thomas Foods International	Lobethal

Follow-up checking of the inspection and data recording process was monitored by examination of data sheets from all establishments on a weekly basis as part of building the database. Dr Hamilton checked procedures during establishment visits as opportunity presented at visits for other projects.

3.2 Consultation with establishment OPVs

With regards to implementing field work at abattoirs nationally, the Principal Investigators briefed Dr Ed Dunn (FOM SA/WA) on the work and seek advice on informing FOMs/OPVs

responsible for participating abattoirs in other regions. At his request a briefing package was prepared including the Communiqué for him to liaise with other OPVs and the OPVs at participating establishments. In addition, Dr Hamilton briefed OPVs at some of the participating abattoir.

3.3 Estimating sensitivity of CLA abnormality detection of current procedures

As the sensitivity of current inspection procedures for CLA are unknown an exercise was conducted to provide an estimate to enable prediction of the non-detection rate against which the effectiveness of an alternative procedure can be assessed.

Project collaborators participated in a modified Delphi expert elicitation on the sensitivity of palpation and visual only CLA inspection similar to that conducted by EFSA (2103a). A full description of the approach is provided in Appendix 2.

4 Results

4.1 Prevalence of CLA abnormalities

The national prevalence and distribution of lesions of CLA on an individual animal basis was recorded on 54,915 sheep and 48,577 goats at slaughter in five sheep and three goat abattoirs over 4 months. A minimum of 6,500 animals were examined at each of the 4 main sheep abattoirs and 3 main goat abattoirs (Table 2). The national prevalence in sheep was 7.7% and 3.0% in goats. A total of 843 sheep and 132 goats had multiple CLA lesions (Table 2).

In terms of meeting project objectives, data were collected at one additional sheep abattoir (3 planned). In terms of animals with multiple lesions a total of 843 were recorded; the target was 300 minima. The numbers varied between abattoirs due to differences in regional prevalence and total numbers monitored at each abattoir.

For goats, only 132 animals with multiple lesions were recorded at 3 abattoirs despite a large sample of 48,577 animals being examined. Abattoir participation for goats met the target. While below the target of 300 the research team did not ask the participants to treble their effort due to logistical consequences and because the lower inherent prevalence in goats than sheep is a factor that may influence the design of alternative procedures.

Table 2: Sheep and goat numbers examined by participating abattoirs over 4 months

	Inspected		With lesions		Multiple lesions	
Plant	**sheep**	**goats**	**sheep**	**goats**	**sheep**	**goats**
A	18,868	0	524	0	103	0
B	6,503	0	335	0	15	0
C	8,408	0	921	0	164	0
D	18,907	33,112	2,282	892	551	92
E	0	7,807	0	358	0	27
F	2,229	7,658	193	218	10	13
Total	54,915	48,577	4,255	1,468	843	132

4.2 Most commonly affected sites – industry and carcase perspectives

The most common carcase sites for CLA lesions **in sheep** in decreasing prevalence were prescapular (4.8%), pre-crural (1.8%) and ischiatic (0.5%) lymph nodes (LN). Prevalence in offal was 1.6%, with lesions in mediastinal LN (0.7%) and lungs (0.8%) the main sites. A bar plot of the relative frequency of sites affected in sheep is shown in Figure 1.

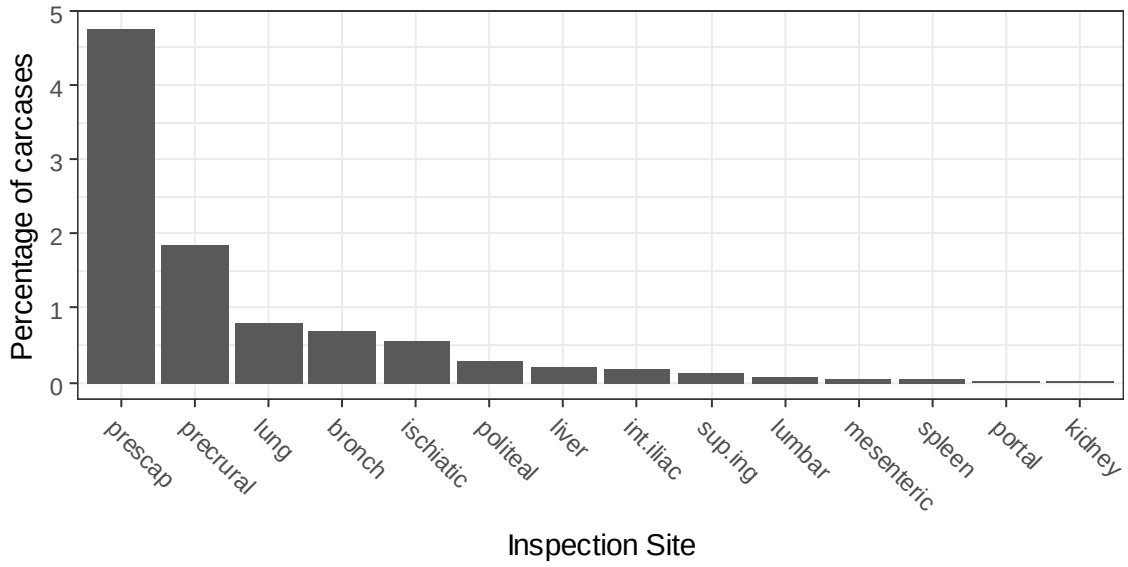

Figure 1: Bar plot of the relative frequency of carcase and offal sites affected in sheep.

With respect to CLA affected sheep, 3,412 (80.2%) had lesions in only one site, 692 (16.3%) had lesions in two sites, 127 (3.0%) had lesions in three sites, and 24 (0.6%) had lesions in four or more sites.

The distribution of lesions in sheep with multiple lesions and co-occurrence of sites is shown in Table 3. Combinations of sites that occurred more than 10% of the time in sheep with multiple lesions were the prescapular in combination with ischiatic, precrural, bronchial and lungs, which were also those sites that occurred most frequently in animals with single lesions.

Table 3: Distribution and co-occurrence of lesions in 843 sheep with multiple CLA lesions.

	n	Prescap	Int. iliac	Lumbar	Ischiatic	Politeal	Precrural	Sup. ing.	Bronch	Portal	Mesenteric	Lung	Liver	Kidney
Prescap	680													
Int. iliac	46	30												
Lumbar	13	9	0											
Ischiatic	127	87	4	0										
Politeal	58	43	3	0	5									
Precrural	401	339	18	6	36	8								
Sup. ing.	34	27	2	0	3	0	3							
Bronch	171	96	6	1	11	7	35	4						
Portal	3	3	1	0	0	0	2	0	0					
Mesenteric	16	12	1	0	0	0	5	0	1	1				
Lung	246	153	10	4	17	7	48	8	78	1	1			
Liver	54	31	0	0	10	1	8	2	10	0	0	16		
Kidney	3	0	0	0	0	0	0	1	0	0	0	1	1	
Spleen	10	4	0	0	3	2	2	0	1	0	0	1	3	0

For goats, the most common carcase sites for CLA lesions in decreasing prevalence were prescapular (2.1%), pre-crural (0.4%) and popliteal LNs (0.2%). Prevalence in offal was 0.3% of carcases, with lesions in mediastinal (bronchial) lymph nodes (0.1%) and lungs (0.1%) the main sites.

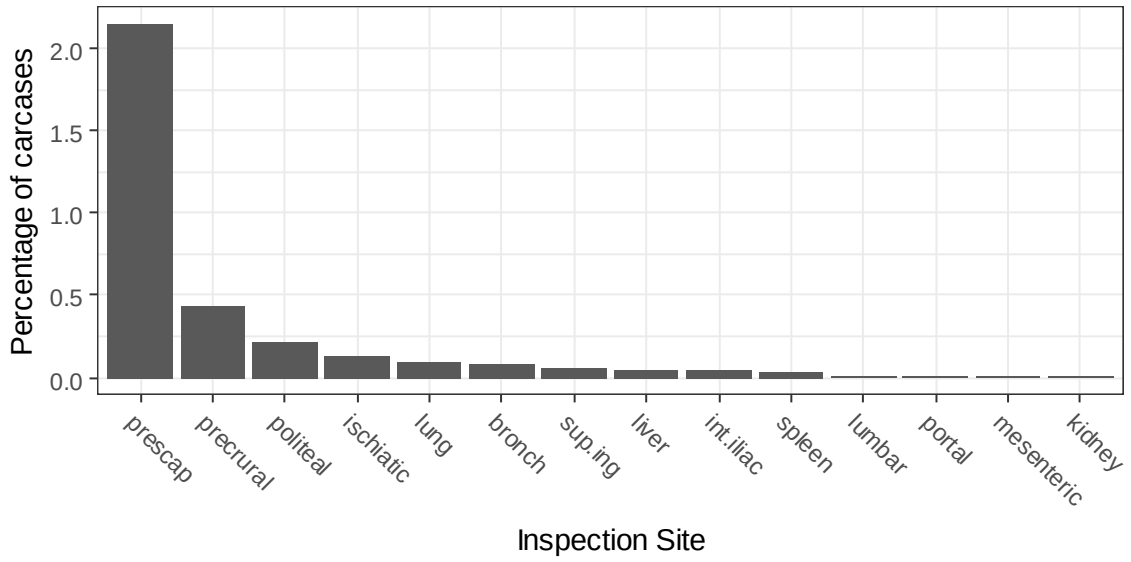

Figure 2: Bar plot of the relative frequency of carcase and offal sites affected in goats.

With respect to CLA affected goats, 1,336 (91.0%) had lesions in only one site, 124 (8.4%) had lesions in two sites, and 8 (0.5%) had lesions in three sites; no goats inspected had more than three sites affected with CLA.

The distribution of lesions in goats with multiple lesions and co-occurrence of sites is shown in Table 4. Combinations of sites that occurred more than 10% of the time in goats with multiple lesions were the prescapular in combination with precrural, popliteal LN, which were also those sites that occurred most frequently in animals with single lesions.

Table 4: Distribution and co-occurrence of lesions in 132 goats with multiple CLA lesions.

	n	Prescap	Int. iliac	Lumbar	Ischiatic	Politeal	Precrural	Sup. ing.	Bronch	Portal	Mesenteric	Lung	Liver	Kidney
Prescap	105													
Int. iliac	8	4												
Lumbar	1	1	0											
Ischiatic	18	9	2	0										
Politeal	27	19	2	0	1									
Precrural	54	43	0	0	6	6								
Sup. ing.	9	5	1	0	0	0	3							
Bronch	13	10	0	0	1	0	0	1						
Portal	1	0	0	0	1	0	0	0	0					
Mesenteric	2	0	0	0	0	0	0	0	0	0				
Lung	16	11	0	0	0	1	2	0	1	0	0			
Liver	6	4	0	0	0	1	1	0	0	0	0	0		
Kidney	0	0	0	0	0	0	0	0	0	0	0	0	0	
Spleen	9	7	0	0	0	0	0	0	0	0	1	1	0	0

4.3 Data to Enable Evaluation of the Effectiveness of Inspection

Assuming that a CLA detection in any one site would trigger a more detailed inspection on the retain rail, the carcase and offal inspection sites, in order of decreasing cumulative inspection effectiveness, are shown in Table 5. For example, for sheep, the most effective site is the prescapular LN, which would identify 61.5% of all CLA affected sheep (including those with CLA in other sites). The site which would identify the next greatest number of affected animals is the precrural LN, which together with the prescapular LN would identify 77.4% of affected sheep.

There is a provision in Schedule 2 of AS4696-2007 (Anon 2007) to excise and discard the pre-scapular, pre-crural and superficial inguinal lymph nodes presumably because these are judged as being most commonly affected with gross abnormalities of CLA. While none of the participating establishments had adopted this option, it is not supported by this new national data on gross abnormality distribution as the superficial inguinal LN is comparatively infrequently affected in both species. These data have been used to inform the design of alternative procedures for the detection of CLA.

Table 5: Ranking of inspection sites by cumulative effectiveness

Sheep			**Goats**		
Site	Additional affected	Cum %	Site	Additional affected	Cum %
Prescap[1]	2616	61.5%	Prescap[1]	1044	71.1%
Precrural[1]	676	77.4%[2]	Precrural[1]	166	82.4%
Bronchial	275	83.8%	Politeal	82	88.0%
Lung	218	89.0%	Ischiatic	47	91.2%
Ischiatic	180	93.2%	Bronchial	30	93.2%
Politeal	97	95.5%	Lung	27	95.0%
Liver	54	96.7%	Sup. inguinal[1]	19	96.3%
Int. iliac	49	97.9%	Liver	17	97.5%
Sup. inguinal[1]	37	98.8%	Int. iliac	14	98.4%
Lumbar	22	99.3%	Spleen	9	99.0%
Spleen	14	99.6%	Lumbar	4	99.3%
Mesenteric	8	99.8%	Mesenteric	2	99.5%
Portal	6	99.9%	Portal	2	99.6%
Kidney	1	100.0%	Kidney	1	99.7%
Other	2	100.0%	Other	5	100.0%
Total	4255		Total	1469	

[1] An equivalent procedure is to excise and discard these lymph nodes without inspection (Schedule 2; Anon 2007)
[2] Prescapular and Precrural LN +ve would identify 77.4% of all CLA affected sheep (including those with CLA in other sites).

4.4 Sensitivity and non-detection rates for current CLA inspection

Additional information has been collated to assist in the design of alternative procedures to deliver equivalent or better food safety and equivalent suitability. For this purpose, a modified Delphi-type estimation was undertaken with qualified and experienced Australian meat inspectors. The sensitivity of detecting CLA in sheep and goats in Australia was estimated as 90% for carcase lesions (Appendix 2).

A prevalence of CLA of 7.7% for sheep and 3.0% for goats, this results in 770/10,000 and 300/10,000 animals affected, respectively. With a 90% sensitivity of detection it is estimated that the current CLA non-detection rate is 86/10,000 sheep and 33/10,000 goat carcases nationally.

5 Discussion

5.1 Overall objective

The overall objective of this project was to provide data to support design and validation of alternative inspection procedures of sheep/goats for CLA that rely less on manual palpation and are sparing on resources while ensuring suitability. The current post-mortem inspection procedures required for CLA in sheep and goats, detailed in AS4696-2007 Schedule 2 Table 2 (Anon 2007), are extensive (Table 6). As CLA is not caused by a foodborne hazard and palpation may be counter-productive (i.e. leads to cross-contamination) examination of alternative procedures is warranted.

The prevalence of CLA in sheep and goats has declined considerably over the past 30 years most likely because of effective animal health interventions (Paton et al 1988, 2002 & 2003). This may have resulted in the most likely sites affected in sheep and goats (Figures 1 and 2) being different to the sites identified for excision/discarding as an equivalent procedure in AS4696 (Anon 2007) (Table 6).

The approach to demonstrating equivalence with AS4696 is based on the "alternative techniques procedure" used by the Australian Meat Regulators Group (ARMCANZ 1997) in which a procedure not listed in AS4696 is compared with the effectiveness of a current procedure i.e. validated quantitatively by extensive testing.

5.2 Alternative inspection procedures – design and validation approach

The type of validation trial to be undertaken was the central initial discussion during a follow-up workshop with collaborators in Adelaide (30 & 31 Jan 2017). The pros and cons of conducting a desktop study versus an extensive field trial in multiple establishments was debated.

In view of the comprehensive data already collected on affected carcase and offal sites and the cumulative effectiveness inspecting various combinations of sites (Table 4), it was decided that an in-plant trial would only duplicate the data already available.

On this basis, it was determined that a desktop evaluation of the effects of changed procedure, i.e. palpation versus visual only, should be conducted. Alternative procedures recommended from the workshop are shown in Table 6. In summary:

- This reduces palpation from 11 sites to 4 sites.
- The lymph node sites with lowest contribution to the cumulative detection rate of CLA gross abnormalities which are the same for sheep and goats (i.e. internal iliac, lumbar and superficial inguinal), are recommended to change from palpate to observe.
- Bronchial / mediastinal LN and lungs are proposed to change from palpate to observe only when lungs are not retained for human consumption.
- A CLA detection in any one site would trigger a traditional (i.e. palpation) carcase inspection either on the slaughter line or on the retain rail pending severity.

The desktop validation will estimate the effectiveness of proposed alternative procedures (Table 6) using data on the cumulative effectiveness of inspection sites (Table 5) in combination with the effects on sensitivity of the changed procedures (Appendix 2). The

estimated non-detection rates arising from changed procedures will be compared to current estimated non-detection rates (Appendix 2) to assess equivalence with AS4696.

Table 6. Proposed alternative inspection sites and procedures for CLA in sheep and goats – V=visual (observe), P=palpate, I=incise.

Lymph Node/Organ	Current	Proposed
Pre-Scap. (Superficial Cervical) LN	P	P
Int. Iliac LN	P	V
Ischiatic LN	P	P
Lumbar LN	P	V
Pre-crural LN	P	P
Popliteal LN	P	P
Superficial Inguinal LN	P	V
Bronchial & Mediastinal LN	P	V/P[1]
Portal LN	V	V
Mesenteric LN	V	V
Lung	P	V/P[2]
Spleen	P	V
Liver	P	V
Kidney	V	V

[1] Anon (2007)
[2] Depending on whether lungs are not / are saved for human consumption; if yes, then current procedures are maintained, i.e. opening of bronchi and observation of internal surfaces.

With regard to head inspection the Expert Panel advised that where brains and/or tongues are collected for human consumption they are either:

- pooled and inspected in batches that are correlated with the carcase and related offal inspection; or

inspected whilst still attached to the carcase.

The propose alternative procedures would substantially reduce potential cross-contamination of carcases resulting from routine Palpation (Appendix 3).

5.3 Assessing equivalence of alternative procedures with AS4696

As a key principle for acceptance of an alternative procedure is to demonstrate quantitatively that it delivers equivalent food safety and suitability to current AS4696 procedures (ARMCANZ 1997). As CLA has no inherent foodborne significance the demonstration of equivalent suitability remains. As there is no baseline data on the effectiveness of current procedures the preliminary data on prevalence and sensitivity detailed in this report provides a basis for validation of alternative procedures.

6 Conclusions/Recommendations

It is recommended that a desktop validation trial be undertaken to assess the effect of current and alternate inspection procedures for CLA (i.e. reduced palpation).

An inherent element of this validation will be a comparison of non-detection rates arising from current and alternative procedures as the basis for judging equivalence with AS4696 (Anon 2007).

Based on the outcomes of this validation it is recommended that changes to current inspection procedures be put to AMRG.

7 Key Messages

- CLA is not a foodborne hazard but a suitability defect
- CLA prevalence is lower than previously reported (80's & 90's) due to effective animal health interventions and current inspection procedures might be altered accordingly
- Sensitivity of current inspection procedures for CLA are estimated to be high (90%)
- Inspection via palpation can lead to cross contamination and overseas countries have moved away from palpation on this basis
- There is opportunity to assess the equivalence of alternative inspection procedures against outcomes resulting from the current procedures of Australian Standard 4696 using the new baseline data on CLA prevalence and distribution of lesions within affected sheep and goat carcases.

Acknowledgments

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Appendix 1: Data collection Standardisation Workshop

Project Title: Efficient detection of Caseous Lymphadenitis (CLA) lesions in sheep and goats at slaughter

Aims of the work

MLA and AMPC has commissioned review of the post-mortem procedures and dispositions in the current red meat Australian Standard 4696 (Anon 2007) will be supported by achieving alternate risk management of Caseous Lymphadenitis (CLA) lesions in sheep and goats through validating:

- removing procedures that are no longer necessary due to the improving herd health status;
- altering or removing procedures where new knowledge of animal or foodborne disease indicates current risk management procedures are ineffective;
- transferring where possible, procedures that are principally related to product quality rather than food safety to companies' QA systems.

The overall goal of this project is to provide evidence to support new protocols for inspection of sheep/goats for CLA that rely less on manual palpation and are sparing on resources while ensuring wholesomeness.

Based on lesion distribution data reviewed it is most likely that there may be different arrangements for sheep and goats.

Data collected in this project can be used to underpin formulation of alternate PM inspection arrangements for CLA for subsequent validation.

Why national approach

- The assessments are to be conducted on a national basis to reflect major production zones to capture any variation that may occur.
- Regulators now adhere to Codex principles, so the one-off, localized studies are not deemed sufficient to justify changes to national standards.

Contributions needed from the establishments

- The project is limited to generating animal level indicators to support changes to post-mortem inspection procedures and inform boning room QA interventions.
- It is most important to obtain data for individual sheep/goats and not merely collect counts within each line.
- 100-150 carcases need to be assessed for distribution of lesions on a carcase by carcase basis at 3 sheep and 3 goat establishments.
- The focus will be on carcases with multiple lesions to design streamlined inspection protocols for validation.

Prior work

- Pilot survey work is underway to establish the prevalence of offal lesions.

- A review of the literature and current national data suggests limited value from present offal inspection.
- Should this be the case it can simplify and reduce the data to be collected on carcases nationally.

Establishments Collaborating

Establishments that have volunteered through AMIC to collaborate include:

- Goats 1 - TFI Lobethal
- Goats 2 – Charleville
- Goats 3 - Wodonga
- Sheep 1 - Fletchers Dubbo
- Sheep 2 - MC Herd Corio
- Sheep 3 - Fletchers Albany
- Sheep 4 - TFI Lobethal

NB: TFI is also assisting with methods development, standardization workshop and offal pilot survey.

Who we need

- From each establishment, we need someone with a Cert IV meat inspection qualification who enjoys trouble-shooting and special projects.
- They need to be able to collaborate with routine operations and inspection while collecting reliable data.

Standardisation Workshop – why

This workshop would be used to

- access the extensive field experience of participants in refining the data collected
- standardise inspection methods,
- capturing efficiencies (focus on known “problem” lots) and
- customizing data recording systems preferred by each establishment.

Data Confidentiality

- All data is subject to disclosure authorization conditions contracted by MAL with the researchers.

Project Milestones

- Commence data collection June 2016
- Half the data collected by mid-September 2016
- All the data collected by mid-December 2016

Project Team

- Dr Andy Pointon - meat safety researcher based in SA
- Dr Dave Hamilton – meat safety researcher, ex-OPV based in SA
- Dr Andreas Kiermeier - Food Safety statistician based in SA

Workshop agenda

Efficient detection of Caseous Lymphadenitis (CLA) lesions in sheep and goats at slaughter

Project workshop 11th and 12th July 2016

Comfort Inn Haven Marina, 6 Adelphi Tce, Glenelg North

Time/location	Activity	Lead
10am – Comfort Inn		
10am	Welcome, introductions, aims, program confirmation	Andy
10.10am	Australian Standard review – Risk assessment approach/CLA	Andy
10.20am	Inspection history and vision	Dave
10.45am	CLA Aims	Andy/Andreas
11am	Industry feedback and practices	Collaborators
11.45am	Offal data – sheep and goats	Andreas/Dave
12:30 pm	Alternative arrangements – sensitivity and specificity Round 1	Andreas/Andy
1pm	Lunch	
1:30 pm	Alternative arrangements – sensitivity and specificity Round 2	Andreas/Andy
2pm	Design – numbers, selection, data recorded, DAWR FOM/OPV notification	Andy/All
3pm	Data collection- logistics, data sheet,?additional data	Dave/Andreas
4pm	Spleens – history, opportunity, pilot data (Vic and SA), design	Andy/Dave/All
5pm	Confirm arrangements for tomorrow	All
6.30pm	Dinner together in Glenelg	All
TFI Lobethal		
8am	Pick up at Comfort Inn -check out	Andy/Dave
9.30am	TFI Lobethal arrival	Lincoln/Dave
10.15am	Slaughter floor inspection viewing	Lincoln/Dave
noon	Lunch	
12.45pm	Review data collection. Spleens Y/N	Dave/Andreas
	Customise data sheets, other issues, timeline	Andreas/All
2.30pm	Depart for airport/Comfort Inn	Andy/Dave
4pm	Airport and Comfort Inn	

Mutton and Goat CLA Lesion Distribution Survey – Data collection sheet

Plant: _____ Date: ____/____/2016 Page: of

Lot Origin (Town)	Lot ID	Lot Size	Location of CLA carcase LN lesions							Location of CLA Offal lesions							Spleen (V-visual; P-palpate)	Other / Comment e.g. other affected sites, severity / disposition, spleen abnormality, etc.
			Pre-Scap.	Int. Iliac	Lumbar	Isch-iatic	Polit-eal	Pre-crural	Sup. inguinal	Bronch Mediast	Portal	Mesen	Lung	Liver	Kidney	Spleen		

Carcase – 1 or 2 to denote # of LN affected per site; **Offal** – tick to indicate CLA presence (no numbers needed); **Spleens** – use V or P to indicate how abnormality was detected; One line per affected carcase (more if needed for comments); **'Other'** column – record spleen abnormality and unusual observations (e.g. very severe cases) or partial/full carcase condemnation.

Appendix 2: Estimating the Sensitivity of Current and Visual-only Post-mortem Inspection for CLA in sheep using a Delphi Approach

Background

As part of the EFSA review of post-mortem inspection procedures, Hardstaff et al. (2012) used the modified Delphi technique to estimate the sensitivity of ante- and post-mortem inspection procedures to detect a range of different animal health disease and welfare conditions. These researchers used "three experts from Australia, New Zealand and Scotland with extensive knowledge and numerous peer reviewed publications on meat inspection, infectious diseases and/or welfare conditions of small ruminants." However, given that this exercise was undertaken in the context of the inspection protocols used in the EU, it was deemed desirable to obtain estimates more specific to Australian post-mortem meat inspection for CLA.

Methods

A project workshop was held on 11 and 12 July 2016 in Adelaide, as reported in the MLA Milestone report for MLA project V.RBP.0022 "Alternative procedures for efficient detection of Caseous Lymphadenitis (CLA) lesions in sheep and goats at slaughter," dated 6 September 2016.

The approach documented by Hardstaff et al (2012) was adopted for MLA Project V.RBP.0022 and the modified Delphi technique was used. The expert panel consisted of five qualified and experienced sheep meat inspectors, who were asked to estimate the sensitivity of post-mortem inspection for CLA in sheep under current inspection procedures (Table A2.1) – all experts confirmed that none were excising and discarding lymph nodes prior to inspection.

Table A2.1: Post-mortem inspection procedures for CLA in AS4696-2007 Schedule 2

Lymph Node/Organ	Palpate	Excise/discard[1]	Observe
Pre-Scap. (Superficial Cervical) LN	+	+	
Int. Iliac LN	+		
Ischiatic LN	+		
Lumbar	+		
Pre – crural LN	+	+	
Popliteal LN	+		
Superfical Inguinal LN	+	+	
Bronchial & Mediastinal LN	+		
Portal LN			+
Mesenteric LN			+
Lung	+		
Spleen	+		
Liver	+		
Kidney			+

[1] Existing equivalent procedure to palpate (Anon 2007)

After explaining the Delphi technique, experts were asked:

What are the probabilities of detection of CLA by visually inspecting the carcass and offal, and by incising the lymph nodes for animals which present with typical and mild signs of infection?

Experts then completed the information on traditional (i.e. current) and visual only post-mortem inspection in the data capture template (Table A2.2). The results were collated, transcribed into a Microsoft Excel spreadsheet and summary statistics were calculated. The numerical and graphical results, together with the EFSA summary estimates, were projected onto a screen, keeping experts' identities anonymous. Experts were allowed to converse while viewing the results so they could reach a common understanding, and then were asked to provide second-round estimates – revising their initial answers if they considered this appropriate. The second-round estimates were again collated and summarised to give final results.

Table A2.2: Data capture template

	Probability of detecting CLA at post-mortem inspection		
Inspection Method	Minimum	Most Likely	Maximum
Traditional			
Visual only			

Results

The final results for traditional and visual only post-mortem inspection for CLA in sheep are shown in Table A2.3. Included in the 'EFSA' estimates are those obtained by Hardstaff et al (2012). These results indicate that Australian experts considered the sensitivity of traditional post-mortem inspection for CLA to be considerably more sensitive than the EFSA experts. With respect to visual only inspection, Australian experts estimated the sensitivity of post-mortem inspection slightly lower than EFSA experts, and considerably lower than traditional inspection.

Table A2.3: Sensitivity estimates for post-mortem inspection for CLA

	Traditional			Visual only		
Expert	Min	Most Likely	Max	Min	Most Likely	Max
1	95.0%	99.0%	100.0%	1.0%	3.0%	10.0%
2	85.0%	90.0%	95.0%	50.0%	55.0%	60.0%
3	80.0%	90.0%	95.0%	50.0%	50.0%	60.0%
4	75.0%	80.0%	90.0%	50.0%	70.0%	75.0%
5	80.0%	90.0%	95.0%	30.0%	40.0%	50.0%
Average	83.0%	89.8%	95.0%	45.0%*	53.8%*	61.3%*
EFSA	56.0%	63.0%	77.0%	49.0%	59.0%	68.0%

* Excluding Expert 1 who was a clear outlier.

Discussion

Traditional inspection procedures have been shown to have poor sensitivity for some abnormalities, particularly at lower prevalences (Hathaway et al 1988; Mousing et al 1997; Willeberg et al 1997; Hamilton et al 2002; Hill et al 2013) i.e. they do not achieve “zero risk”.

Quantitative risk assessment approaches do not claim to deliver zero risk, but should be used to inform the allocation resources according to risk; this principle can be applied equally to achieving equivalent suitability.

In the overall context of a national prevalence of CLA of 7.7% for sheep and 3.0% in goats this results in 770/10,000 and 300/10,000 affected, respectively (Pointon et al 2016b).

With a 90% sensitivity, it is estimated that under present inspection protocols (Schedule 2 Anon 2007) the non-detection rate for CLA is estimated at 86/10,000 sheep and 33/10,000 goat carcases.

These sensitivity estimates provide a basis for understanding non-detection rates under current arrangements to serve as a basis for setting equivalence targets for alternative inspection arrangements.

Appendix 3: Cross-contamination with foodborne Hazards

When justifying the cessation of palpation of lambs for CLA in the US, Walker *et al* (2000) reviewed the importance of cross-contamination and given that the current post-mortem procedures involve palpation and incision of some organs, he concluded the potential for cross-contamination of carcases exists and procedures were changed accordingly.

EFSA (2013) *Scientific Opinion on the public health hazards to be covered by inspection of meat from sheep and goats* recognised the need that methodologies may need to be reviewed considering risks of possible cross-contamination. EFSA observes the main weakness of post-mortem inspection (of spleens) is that they are not able to detect the public health hazards identified as the main concerns for food safety. This “hidden” hazard transfer has been demonstrated in Australia by palpation of lymph nodes for CLA (Jordan et al 2012) where the expected *E. coli* density per unit area was 6 times higher after inspection (13 cfu/cm^2) compared with before inspection (2 cfu/cm^2).

In another Australia report Smeltzer et al (1980) demonstrated the rate of *Salmonella* contamination on the hands of inspectors was in the order of that found on hands of workers performing trimming, evisceration and boning (i.e. 30-40%) in a sheep abattoir.

However, the contamination rates of processing workers may be considerably reduced today because of the introduction of HACCP-based QA systems in the mid-1990s (Sumner *et al* 2011). Repeated microbiological baseline surveys of red meat and pork dressing over this timeframe that show improved meat hygiene may reflect an improvement in this area (Vanderlinde *et al* 1998; Phillips *et al* 2001, 2006, 2012; Hamilton *et al* 2011).