final report

Project code: G.MFS.0291

Prepared by: A. Pointon
AP Food Integrity Pty Ltd

Date published: January 2013

PUBLISHED BY
Meat & Livestock Australia Limited
Locked Bag 991
NORTH SYDNEY NSW 2059

Risk-Based Assessment of Beef, Sheep and Goat Inspection at Australian Abattoir

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

Table of Contents

Section 1. Introduction

1.1 Objectives:Outputs

The objectives are to;

1. Conduct a Hazard Identification of red meat and meat products – output is "hazards likely to occur" and potential hazards
2. Identify gross carcase abnormalities typically associated with "hazards likely to occur" – does inspection reduce hazard levels in fresh meat
3. Identify hazards that result in typical (diagnostic) gross abnormalities – reliability of inspection to detect known hazards
4. Attribute gross abnormalities in the Australian Standard under the following categories: OIE surveillance, foodborne, uncertain, aesthetic/production and animal welfare – to provide a risk-based rationale for the level of inspection stringency and training required for various outputs
5. Identify potential hazards warranting future consideration – focus on emerging risks
6. Predict the most effective points at which to detect these abnormalities – provide a risk-basis for detection and removal of grossly detectable abnormalities ("pathology").

1.2 Background

Current post-mortem inspection procedures are labour intensive and mainly target grossly detectable abnormalities which have been assessed to be a minor source of foodborne hazards to consumers. Traditional procedures remain largely unchanged, despite their scientific validity and cost effectiveness having been strongly challenged over many years (Hathaway and McKenzie 1991, Berends et al 1993; Mousing et al 1997; van Knappen 1997; Edwards et al 1997; Pointon et al 2000) leading to adoption of alternative inspection procedures (Hamilton et al 2002).

The risk assessment approach (CAC 1999, 2005) provides a scientific basis for the optimum allocation of resources to maximise food safety.

The framework advocated by Davies and Stärk (2006) (Table 1) provides a basis for matching training and inspection procedures/intensity with intended purpose.

Table 1. Levels and objectives of surveillance systems (Davies & Stärk, 2006)

Level	Objective	Purpose
National (State)	Demonstrate freedom from disease	Maintain trade access
	Outbreak detection	Facilitate response capability for exotic and novel diseases
	Disease control and eradication	Optimise operational efficiency of regulatory programs
	Monitor notifiable diseases	Gather epidemiological intelligence to support regulatory policy
	Monitor zoonotic and food-borne pathogens	Protect public health, maintain trade access
	Monitor emerging diseases	Early detection of novel pathogens or changing pathogenicity of organisms
Industry/ Corporate	Assure freedom from disease	Breeding stock suppliers – boar stud, protect production pyramids
	Outbreak detection	Protect production pyramids
	Define herd/flock disease status	Inform animal flow decisions
	Monitor endemic production diseases	Epidemiological intelligence to support health management decisions
	Monitor zoonotic and food-borne pathogens	Public health and trade access; quality assurance and product differentiation
	Indexes of animal welfare	Address consumer concerns – quality assurance

1.3 Methods

Review published foodborne outbreak reports to conduct a Hazard Identification.

Establish which of these "hazards likely to occur" cause grossly pathology detectable by inspection at slaughter.

Review disease/condition aetiologies to qualitatively risk rate grossly detectable pathology.

Identify pathology that may indicate potential hazards.

Section 2. Hazard Identification

2.1 Definitions

For the purpose of this exercise both recognised and potential food safety hazards are identified and have been extracted from Meat and Livestock Australia (2003a,b) and Pointon et al (2007).

Recognised hazards are those that are reported as causing illness as a result of consuming meat or meat products. Meat borne hazards considered include biological (micro-organisms), physical (foreign matter) or chemical agents (residues, heavy metals). Biological hazards also include macrobiological hazards (i.e. gross carcase abnormalities resulting from organisms or pathology associated with certain animal parasites and disease). Chemical hazards include residues from contaminants in the environment (e.g. cadmium, dioxins) and agricultural and veterinary chemicals used on-farm, including those which may be safe in small amounts but have a maximum residue limit (MRL) and natural toxins. Physical hazards considered were those which may enter during primary production; examples include broken injection needles and lead shot.

Potential hazards include those that may result in public health, social and/or economic impact but for which epidemiological evidence of recorded disease cases caused by the hazard is lacking (uncertainty) e.g. *Mycobacterium paratuberculosis* and plant-associated toxins.

Furthermore, in the case of beef measles, as no cases were recorded for the study period in Australia (Pointon et al 2007) this is reported as a potential hazard.

Food safety-related market access hazards are potential hazards related to food safety which may or may not be valid foodborne hazards but are technical requirements to trade (e.g. Hydatids, Sarcosporidiosis, Johnes Disease).

2.2 Microbial Hazard:Product Combinations

Microbial hazard:meat product combinations associated with illness attributed to beef and sheep meat in Australia from 1991 to 2006 are shown in Tables 2 and 3 and for the processing sector in Table 4, respectively. Details of outbreaks up to 2003 are reported by Meat and Livestock Australia (2003a) and from 2003-2006 from OzFoodNet by Pointon et al (2007).

2.3 Hazard Identification

2.3.1 Beef and Beef Products

Outbreaks of foodborne illness associated with fresh beef and beef products are predominantly due to hazards typically introduced post-cooking (*Staphylococcus aureus* and *Clostridium perfringens)* (Table 2). A comprehensive review of these hazards on a though-chain basis, including the primary source for these foodborne outbreaks (e.g. food handlers, food preparation environment), is provided by Food Science Australia & Minter Ellison Consulting (2002) and Meat and Livestock Australia (2003b).

Salmonella spp. as the cause of foodborne outbreaks is relatively infrequent, potentially reflecting the low isolation rate from beef carcases detected by ESAM and national baseline surveys (summarised by Pointon et al 2007).

Table 2. Reported beef-associated outbreaks in the food service sector where the hazard was identified in Australia (1991-2006) – Source Food Science Australia (2002), Meat and Livestock Australia (2003a) and Pointon et al (2007)

Year	Product	Hazard	Cases (deaths)
1993	Roast beef or pork	*C. perfringens*	25
1993	Roasted, minced beef	*C. perfringens*	37
1997	Beef casserole	*C. perfringens*	36
2000	Thai beef salad	*Salmonella*	21
2000	Roast beef or pork	*C. perfringens*	5
2001	Eye fillet meal	*S.* Typhimurium PT 99	95
2001	Beef curry	*C. perfringens*	8
2001	Reef and Beef meal	*C. perfringens*	15
2002	Spit roast beef and/or pork	*C. perfringens*	16
2005	Rice, beef and black-bean sauce	*S. aureus*	5
2005	Braised steak & gravy	*C. perfringens*	36
2005	Beef rendang	*C. perfringens*	3
2005	Roast beef, pork, chips, gravy	*S. aureus*	2

2.3.2 Sheep Meat and Sheep Meat Products

Outbreaks of foodborne illness associated with sheep meat and sheep meat products are shown in Table 3. These are predominantly due to hazards typically introduced post-cooking (*Clostridium perfringens* and *Staphylococcus aureus)* as with beef. Offal (liver) contaminated with *S.* Typhimurium was implicated in two outbreaks.

Table 3. Reported sheep meat-associated outbreaks in the food service sector where the hazard was identified in Australia (1991-2006) – Source Food Science Australia (2002), Meat and Livestock Australia (2003a) and Pointon et al (2007)

Year	Product	Hazard	Cases (deaths)
1997	Roast lamb	*C. perfringens*	12
1999	Roast lamb	Viral	74
2000	Lamb curry	*C. perfringens*	14
2001	Lambs fry	*S.* Typhimurium PT 99	22
2002	Lamb curry	*C. perfringens*	70
2005	Lambs liver	*S.* Typhimurium	43
2005	Chicken and/or lamb guvec	*C. perfringens*	14
2005	Suspected lamb dish	Suspected Staph toxin	10
2006	Suspected lamb hotpot, lamb cutlets, hommus, baba ghanoush dip	*S.* Zanzibar	3

2.3.3 Goat Meat and Goat Meat Products

Foodborne outbreaks attributed to goat meat were not reported over the study period 2002-2006 (Pointon et al 2007). However, *Salmonella* spp. were recovered at a substantially higher rate from goat carcases than beef or sheep carcases over the same period (Pointon et al 2007) and as such should be considered as an identified foodborne hazard where goat meat is the primary source.

2.3.4 Manufactured and Processed products

Examination of outbreaks associated with manufactured and processed meat products (Table 4) reveals *Salmonella* spp. as the leading cause, however, outbreaks due to pathogenic *E. coli* and *Listeria monocytogenes* has been reported in Australia.

Table 4. Meat-borne outbreaks associated with the processing sector where the hazard was identified in Australia (1991-2006) – Source Food Science Australia (2002), Meat and Livestock Australia (2003a) and Pointon et al (2007)

Year	Product	Hazard	Cases (deaths)
1991	Uncooked fermented meat	*S.* Anatum	>120
1992	Uncooked fermented meat	*S.* Typhimurium	>20
1995	Uncooked fermented meat	*E. coli* O111	>150 (1)
1996	Unknown*	*E. coli* O157	6
1996	Meat rolls	*S.* Typhimurium PT 135	71
1996	Cold roast meat	*C. perfringens*	33
1997	Cured, cooked meat	*S.* Muenchen	24 (2)
1997	Unknown*	*S.* Typhimurium PT 43	7 (1?)
1997	Cured, cooked meats	*S.* Anatum	25
1997	Unknown*	*S.* Chester	25
1999	Pizza	*E. coli* O15	(1)
1999	Pan rolls	*S.* Hessarek	>11 (1)
2000	Asian food	*S.* Typhimurium RDNC	6
2000	Asian food	*S.* Typhimurium PT 44	11
2000	Sucuk (fermented sausage)	*S.* Typhimurium PT 170	6
2000	Frankfurters	*S.* Typhimurium PT 9	5
2001	Fermented sausage (home-made)	*S.* Typhimurium PT 135a	3
2002	Uncooked fermented meat (cacciatore)	*E. coli* O157	1
2004	Pizza	*C. perfringens*	6
2005	Silverside-corned beef	*L. monocytogenes*	5 (3)

* Meat was the suspected vehicle

2.3.5 Key findings and implications – beef, sheep and goat meats

Hazards likely to occur for red meat species include *Salmonella* spp., pathogenic *E. coli*, *Clostridium perfringens, Staphylococcus aureus* and *L. monocytogenes* (Tables 2, 3 and 4).

Potential hazards for beef, sheep and goat meats (Tables 5, 6 and 7) are also included from work undertaken for FSANZ by Pointon et al (2007).

For *Salmonella* there are insufficient outbreaks and isolates to inform attribution by comparison of the relative frequency of isolation of serovars associated with outbreaks with product monitoring by NEPSS and ESAM.

Use of molecular typing methods will greatly enhance the confidence in attribution to particular sources.

The relationship or these identified and potential hazards with "pathology" detectable at routine slaughter inspection is examined in the following section.

Table 5. Summary of hazards found in association with beef and beef products (extracted from Pointon et al 2007)

Hazards likely to occur	**Principal Source(s)**
Salmonella spp.	Farm, abattoir, food preparation
Pathogenic *E. coli*	Farm
Clostridium perfringens	Processing, catering (post-cooking)
Staphylococcus aureus	Processing, catering (post-cooking)
Potential hazards	**Source(s)**
Campylobacter sp.	Farm
Mycobacterium avium subsp. paratuberculosis	Farm
BSE	Meat meal of ruminant origin
Beef measles	Farm
Toxoplasma gondii	Farm
Ag and Vet chemical residues	Animal and pasture/fodder treatments
Corynetoxins, Indospicine	Feed

Table 6. Summary of hazards found in association with sheep meat and sheep meat products (extracted from Pointon et al 2007)

Hazards likely to occur	**Principal Source(s)**
Salmonella spp.	Farm, abattoir, processing, catering
Clostridium perfringens	Processing, catering (post-cooking)
Staphylococcus aureus	Processing, catering (post-cooking)
Potential hazards	**Source(s)**
Campylobacter sp.	Farm
Pathogenic *E. coli*	Farm
BSE	Meat meal of ruminant origin
Toxoplasma gondii	Farm
Mycobacterium avium subsp. paratuberculosis	Farm
Ag and Vet chemical residues	Animal and pasture/fodder treatments
Corynetoxins	Feed grains

Table 7. Summary of hazards found in association with goat and goat meat products (extracted from Pointon et al 2007)

Hazards likely to occur	**Principal Source(s)**
Salmonella spp.	Farm, abattoir
Potential hazards	**Source(s)**
Campylobacter sp.	Farm
Pathogenic *E. coli*	Farm
Mycobacterium avium subsp. paratuberculosis	Farm
Clostridium perfringens	Processing, catering (post-cooking)
Staphylococcus aureus	Processing, catering (post-cooking)
BSE	Meat meal of ruminant origin
Toxoplasma gondii	Farm
Ag and Vet chemical residues	Animal and pasture/fodder treatments

Section 3. Risk-based Assessment of Grossly Detectable "Pathology"

3.1 Risk-based assessment of "Pathology" and Key Findings

For this assessment the diseases/conditions listed in Table 8 have been extracted from the Australian Standard Schedule 3 – Ante-mortem and Post-mortem Dispositions (Anon 2007) and from OIE listings.

In Table 8 these conditions/diseases have been classified as;

- **Foodborne hazard** – as described in Definitions of this report
- **Zoonotic** – infections transmitted from animals to humans in addition to the Foodborne Hazards listed above
- **Uncertain** - as described in Definitions of this report
- **Wholesomeness/production** – those that affect the wholesomeness as described in the Australian Standard (Anon 2007) and those resulting from previous diseases and conditions unrelated to foodborne/zoonotic hazards, which largely overlap
- **Welfare** –conditions/diseases adversely impacting animal well-being proposed by Anon (2011), accepting the inherent biases of slaughter populations.

In addition the points at which these lesions/"pathology" are best detected (Table 8) is provided by the author alone, and should be the subject of further expert opinion. It is provided for example only. For several diseases/conditions the first point of "inspection" is recommended to be the farm as part of Good Agricultural Practices as in the Livestock Production Assurance Scheme (Horchner et al 2006), and as advocated by EFSA (Anon 2011).

Table 8. Risk-based assessment of grossly detectable pathology at abattoir inspection

Abnormality AS 4696:2007 & OIE	"Typical" Pathology	OIE List Category	Foodborne	Zoonotic	Uncertain Hazard	Wholesome Production	Welfare	Inspection point(s)	Reference
OIE									
BSE[1]		B	Yes					Farm/AM	www.oie.int
Acute Salmonellosis (non-typhoidal)		C	Yes					AM/PM	www.oie.int
Acute Brucellosis[2]		B	Yes (Milk)					PM	www.oie.int
Melioidosis		C		Yes				PM/boning	www.oie.int
Anthrax	Yes	B		Yes				Farm/AM	www.oie.int
Listeriosis		C	Yes[5]					Farm/PM	www.oie.int
Echinococcosus – Hydatids	Yes	B		Yes				PM	www.oie.int
AS 4696:2007 1. General									
Cachexia						Yes	If severe	AM/PM	
Anaemia						Yes		PM	
Injury/accidental trauma						Yes	Yes	AM/PM	
Septicaemia, pyaemia, toxaemia			Yes *Salmonella*					PM	
2. Aetiological list									
2.1 Bacterial/related List									
Actinomycosis	Yes					Yes		PM	Hagan's
Actinobacillosis	Yes					Yes		PM	Hagan's
Acute Leptospirosis	Yes			Yes				PM	Hagan's
Anaplasmosis - jaundice						Yes		PM	Jubb
Babesiosis - jaundice						Yes		PM	Jubb
Blackleg (*Clostridia*)	Yes					Yes		PM	Jubb
Botulism			Yes[6]					AM	Hagan's
Caseous lymphadenitis	Yes					Yes		PM/boning	MLA 2003a,b

Abnormality AS 4696:2007 & OIE	"Typical" Pathology	OIE List Category	Foodborne	Zoonotic	Uncertain Hazard	Wholesome Production	Welfare	Inspection point(s)	Reference
Enterotoxaemia (*Clostridia*)						Yes		PM	Jubb
Eperythrozoonosis - anaemia						Yes		PM	Hagan's
Footrot - abscessation						Yes		AM/PM	Jubb
Inf Ovine Epididymitis (*B. ovis*)	Yes					Yes		Farm/PM	Hagan's
Johnes disease (Mptb)	Yes				Yes[7]	Yes		AM/PM	Risk Profile
Malignant oedema (*Clostridia*)						Yes		PM	Hagan's
Necrobacillosis - abscessation						Yes		PM	Hagan's
Purpura haemorrhagica						Yes		PM	
Tuberculosis[3]			Yes (milk)					PM	MLA 2003a,b
Newborn - White Scour, navel ill, polyarthritis						Yes		AM/PM	
2.2 Parasitic conditions									
Cyticercus bovis	Yes		Yes					PM	MLA 2003a,b
Cyticercus cellulosae						Yes		PM	Jubb
Cysticercus ovis	Yes					Yes			Jubb
Cysticercus tenuicollis						Yes			Jubb
Myiasis (blowfly)	Yes					Yes	Yes	AM	
Oestrus ovis						Yes		Farm/AM	Jubb
Onchocerciasis	Yes					Yes		AM	Jubb
2.3 Protozoan diseases									
Coccidiosis						Yes		AM/PM	Jubb
Sarcosporidiosis[3]	Yes					Yes		PM	MLA 2003a,b
2.4 Viral diseases									
Bovine leucosis						Yes		PM	Jubb
Bovine para-influenza						Yes		PM	Jubb
BVD/MD						Yes		AM/PM	Jubb

Abnormality AS 4696:2007 & OIE	"Typical" Pathology	OIE List Category	Foodborne	Zoonotic	Uncertain Hazard	Wholesome Production	Welfare	Inspection point(s)	Reference
Ephemeral fever						Yes		PM	Hagan's
2.5 Fungal diseases									
Aflatoxicosis						Yes		PM	Jubb
2.6 Non-infectious conditions									
Delay in evisceration						Yes		PM	
Ecchymosis						Yes		PM	
Foreign objects (grass seeds)						Yes		Farm/AM	
Jaundice						Yes		PM	
Transit tetany/ketosis						Yes		AM	
Residues (MRL, ML)[4]						Yes		Farm/PM	MLA 2003a,b
Tumours	Pink eye					Yes		AM/PM	Jubb
3. Topographical listing									
3.1 Nervous system									
Encephalitis/meningitis						Yes		AM/boning	
Brain abscess						Yes		AM/boning	
3.2 Cardiovascular system									
Acute pericarditis						Yes		PM	
Chronic pericarditis						Yes		PM	
Endocarditis						Yes		PM/boning	
Non-infectious heart lesions						Yes		PM/boning	
3.3 Respiratory system									
Atelectasis, emphysema, pigmentation, blood						Yes		PM	
Bronchitis						Yes		PM	

Abnormality AS 4696:2007 & OIE	"Typical" Pathology	OIE List Category	Foodborne	Zoonotic	Uncertain Hazard	Wholesome Production	Welfare	Inspection point(s)	Reference
Multiple pulmonary abscesses						Yes		PM	
Periacute pneumonia						Yes		PM	
Pneumonia/bronchopneum						Yes		PM	
Sinusitis						Yes		?boning	
3.4 Pleura									
Adhesions						Yes		PM	
Diffuse pleurisy						Yes		PM	
3.5 Gastrointestinal tract									
Acute enteritis (haemorrhagic)			Yes (*Salm*)					AM/PM	
Chronic GI cattarh						Yes			
3.6 Peritoneum									
Adhesions						Yes		PM	
Peritonitis – acute & localised						Yes		PM	
3.7 Liver									
Abscesses						Yes		PM	
Fatty infiltration						Yes		PM	
Hepatitis						Yes		PM	
Miliary necrosis in calves						Yes		PM	
Parasitic lesions/nodules						Yes		PM	
Telangiectasis, cysts						Yes		PM	
3.8 Kidney									
Bladder rupture						Yes		PM	

Abnormality AS 4696:2007 & OIE	"Typical" Pathology	OIE List Category	Foodborne	Zoonotic	Uncertain Hazard	Wholesome Production	Welfare	Inspection point(s)	Reference
Calculi, cysts, pigmentation						Yes		PM	
Nephritis						Yes		PM	
3.9 Genital tract									
Acute/chronic metritis						Yes		PM	
Orchitis, epididymitis						Yes		PM	
Prolapse, torsion, rupture						Yes	Yes	Farm	
Retained placenta						Yes	Yes	Farm	
3.10 Udder									
Mastitis								Farm	
Oedema								PM	
3.11 Musculo-skeletal system									
Abnormal pigmentation						Yes		PM	
Athritis (poly)						Yes	Yes	Farm/AM	
Fractures						Yes	Yes	AM	
Mysositis/ dystrophy						Yes		PM	
3.12 Skin									
Bruising						Yes		PM	
Burns						Yes	Yes	Farm	
Photosensitisation						Yes		Farm	
Wounds/cellulitis						Yes		Farm/AM	

[1] Not found in Australia (Animal Health Australia 2007a)

[2] Eradicated (Animal Health Australia 2007b)

[3] Eradicated (Pearce et al 2009)

[4] Sampled at abattoir for verification

[5] Foodborne hazard due to post cooking contamination and time/temp abuse (Bell and Kyriakides 2009)

[6] Foodborne hazard due to insufficient processing control (MLA 2003b)

[7] Potential meat-borne hazards of trade significance (MLA 2003b)

3.2 Abattoir post-mortem carcase condemnation data and key findings

Currently the Export Production and Condemnation Statistics (EPACS) database is able to maintain partial surveillance data relating to animals condemned at the abattoir. While condemnation data is available (Meat & Livestock Australia, 2003a) background epidemiological information is unavailable, preventing interpretation in all but very general terms at the broad slaughter age/class of livestock level. Furthermore, data on partial condemnations is not continually recorded. For sheep this omits a major cause of partial condemnation (*C. ovis* – sheep measles) that has been of increasing market access concern (Carol Sheridan, AQIS, pers. comm.).

The main reasons for total carcase condemnation in Australia (Meat & Livestock Australia, 2003a) are:
Calves – fever (28 condemned/10,000 carcases) and jaundice (11/10,000)
Steer/heifers – malignancy/cancer eye (0.56/10,000), septicaemia (0.45/10,000) and septic pneumonia (0.42/10,000)
Cow/bull – malignancy (including cancer eye) (18/10,000), fever (3.29/10,000), emaciation (2.37/10,000) and septicaemia (2.29/10,000)
Lambs – polyarthritis (2/10,000), sheep measles (1/10,000) and fever (1/10,000)
Sheep – emaciation (28/10,000), CLA (10/10,000) and fever (7/10,000)
Goats (skin off) – fever (35/10,000), emaciation (23/10,000) and gross contamination (10/10,000)
Goats (skin on) – gross contamination (31/10,000), fever (25/10,000) and emaciation (10/10/000).

More recent EPACS data for 2007 provided by AQIS in most part reflects the major causes of condemnation cited above (P. Smith, AQIS, pers. comm.). Additional common causes of condemnations are:
Steer/heifers – polyarthritis
Lambs – jaundice
Sheep – malignancy and sheep measles
Goats – CLA.

The main reasons for partial condemnations reported by Paton (1994) from WA are:
Calves (up to one year) – pleurisy/pneumonia (3.3%), liver abscess (1.3%) and nephritis (0.9%)
Steers – liver abscess (1.3%), rumen (anthelmintic) injection abscess (0.4%) and traumatic reticulitis (0.4%)
Cows – pregnancy (3.2%), liver abscess (2.0%) and pneumonia/pleurisy (1.3%)
Lambs – pleurisy/pneumonia (5.6%), *C. tenuicollis* (3.9%) and arthritis (1.4%)
Sheep – CLA (22% of all stock monitored), by *C. tenuicollis* (bladder worm) (6.8%) and pleurisy/pneumonia (4.7%).

From the risk-based framework utilised in Table 8 there is little evidence that these carcase condemnations result in reduced levels of foodborne hazards. By this assessment these causes provide significant insight into production problems and consequential processing inefficiencies.

3.3 Key findings and Implications

1. The source of most identified foodborne hazards (Section 2 – "hazards likely to occur") is not attributed to contamination from grossly detectable pathological lesions.

In relation to fresh meat most outbreaks are attributed to hazards typically introduced post-cooking e.g. *Clostridium perfringens* and *Staphylococcus aureus* (Food Science Australia & Minter Ellison Consulting 2002; MLA 2003b). While strains of these bacteria cause disease and gross lesions detectable at slaughter (Table 8), contamination from pathology is not attributed as the primary source for foodborne outbreaks. While *Salmonella* spp. may cause septicaemia the associated pathology is far from pathognomonic ("Typical").

While strains of these hazards may cause disease in animals with consequential pathology, animals with symptoms of acute haemorrhagic enteritis or clostridial enterotoxaemia should not be submitted for slaughter under Livestock Production Assurance health declaration arrangements (Horchner et al 2006; Anon 2013) or be passed fit for slaughter by ante-mortem inspection (Anon 2007).

The situation with identified hazards associated with processed and manufactured meats is similar. Post-cooking/processing contamination from pathology is not attributed as the cause of foodborne outbreaks; pathogenic *E. coli* do not directly cause grossly detectable pathology (reviewed by Pointon et al 2012) and the primary source of *Listeria monocytogenes* in outbreaks is principally from the food manufacturing environment (Bell and Kyriakides 2009) Animals with clinical Listeriosis should not be submitted or passed fit for routine slaughter (Horchner et al 2006; Anon 2007; Anon 2013).

2. Very few foodborne hazards associated with red meat cause typical (diagnostic) gross abnormalities detectable at slaughter.

These include *Cyticercus bovis* (Beef measles) and potentially acute haemorrhagic enteritis due to *Salmonella* infection.

Tuberculosis and Brucellosis in cattle, while foodborne are transmitted by ingesting contaminated milk rather than ingested meat. Both have been eradicated from the Australian beef herd (Animal Health Australia 2007b; Pearce et al 2009).

While Echinococcosus – Hydatid pathology is deemed "typical" (Table 8), lesions in slaughter animals are an indicator for infected canines in the production area. Lesions in beef, sheep and goat carcases are directly infective to canines, not humans.

For the purposes of this assessment a lack of reported cases over the recent period examined has these listed as either potential foodborne hazards (Tables 5, 6 and 7) or non-foodborne zoonosis (Table 8).

3. Uncertain zoonotic hazards represent potential market access barriers.

The classic example of uncertainty is Johnes Disease caused by *Mycobacterium avium subspecies paratuberculosis.*

While the resulting grossly detectable pathology is considered "typical" for this infection, its ability to cause foodborne infection in humans remains unconfirmed. As a result a precautionary approach is taken by trading partners and Johnes Disease remains of considerable regulatory importance that includes surveillance of slaughter stock as part of approved disease control arrangements (MLA 2003b).

4. Many diseases/conditions occurring during production cause pathology unacceptable to consumers but don't present any foodborne risk.

This category represents by far the bulk of grossly detectable pathology at inspection. The resulting pathology negatively affects the wholesomeness of product for consumption requiring it to be detected and removed to meet market requirements.

Due to the aesthetic nature of this pathology opportunity arises to allocate more highly trained inspectors to the detection and removal of pathology associated with foodborne hazards and those that may present market access risks (i.e. OIE listed, JD etc).

On a risk-basis the detection and removal of aesthetic pathology/abnormalities could be reallocated within GMP/HACCP-based processing systems with regulatory oversight.

5. Causes of carcase condemnations are not related to food safety in a causal manner

Examination of the main pathology associated with carcase condemnation (Section 2.3) using the same criteria as used in Table 8 reveals the main causes to be unrelated to food safety.

This does not exclude increased potential for secondary contamination with foodborne hazards, however, in pigs classified as "suspect" at ant-mortem inspection, Jackowiak et al (2006) found the rate of isolation of *Salmonella* in ingesta from these pigs was the same as in batch-matched healthy controls.

Pathology largely leading to carcase condemnations is the result of diseases and conditions that impact negatively on production and processing efficiency. They adversely affect wholesomeness. Data on partial condemnations is unpublished.

6. Opportunity exists for better classification, detection and feedback reporting to producers for pathology resulting in unacceptable animal welfare

The inclusion of pathology indicative of unacceptable animal welfare in the EFSA studies cited reflects the increasing community expectation or "social licence" in relation to industry's responsibilities concerning animal welfare, environmental sustainability and traditionally food safety.

While ante-mortem inspection has always had a strong animal welfare component, the trend is to more openly communicate that post-mortem inspection can also play a useful role. Some development of standardised dispositions is, however, required to ensure consensus among stakeholders.

Section 4. Conclusions

For the Australian red meat industry the detection and removal of grossly detectable pathology contributes little to reducing foodborne risk attributable to consumption of fresh meat and meat products. This reflects the observations of the previous authors (Section 1.2), the effective control and /or elimination of potential foodborne hazards under current production methods and other primary sources of contamination.

The framework for modernisation of meat inspection post-elimination of zoonoses such as Tuberculosis etc was elaborated as an output of the World Congress on Meat and Poultry Inspection (Anon 1997; van Knappen 1997).

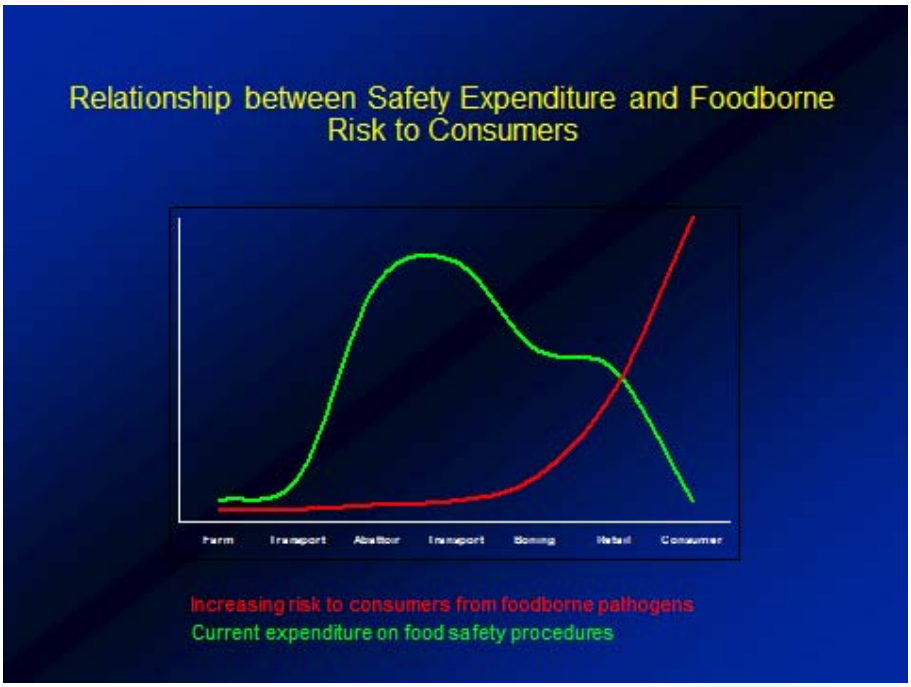
While inspection provides surveillance of important food safety trade-related conditions, the sensitivity and specificity of this process is likely to be poor and is the subject of a major EFSA study.

The bulk of the inspection effort and cost targets the detection of grossly detectable pathology of no foodborne risk.

It is, therefore, possible for consideration of a reallocation of inspection resources and capability to assure the wholesomeness of the product potentially within the framework of a quality assurance system based on process control (GMP, HACCP-based) procedures.

Without reform there will continue to be e miss-alignment between expenditure on food safety management and where foodborne risk arises (Figure 1).

Figure 1. Qualitative relationship between expenditure food safety and where risk arises for the red meat industry.



References

Animal Health Australia (2007a) TSE Freedom Assurance Program. http://www.animalhealthaustralia.com.au/aahc/interest-areas$/index.cfm?E8CD3CBB-B6FE-86D4-A979-E448E6D3D950 Last updated 3 April 2007.

Animal Health Australia (2007b) Brucellosis (*Brucella abortus*). http://www.animalhealthaustralia.com.au/aahc/index.cfm?FFD1E4B2-0167-2FA4-3788-7099C0D9AEB9. Last reviewed January 2006.

Anon (1997) The Ruwenberg Conference. World Congress on Meat and Poultry Inspection in the Next Century. June 1997. The Netherlands, Ministry of Agriculture, Nature Management and Fisheries. pp 171-174.

Anon (2007) Australian Standard for the Hygienic Production and Transportation of Meat and Meat Products for Human Consumption. FRSC Technical Report 3, AS 4696:2007.

Anon (2011) Scientific Opinion on the public health hazards to be covered by inspection of meat (swine). *EFSA Journal* 9 (10): 2351.

Anon (2013) http://www.mla.com.au/Meat-safety-and-traceability/Livestock-Production-Assurance/Vendor-declarations/LPA-NVD-Waybills.

Bell and Kyriakides (2009) In Foodborne Pathogens 2nd Edition. Eds Blackburn, C. and *McClure, P.J. Woodhead Publishing Limited. Oxford. 673-717.*

Berends, B. R., Snidjers, J. M. A. & Van Logtestijn, J. F. (1993) Efficacy of current EC meat inspection procedures and some proposed revisions with respect to microbiological safety: a critical review. *Veterinary Record* **133**,411-415

Codex Alimentarius Commission (1999) Principles and Guidelines for the condusct of Microbiological Risk Assessment CAC/GL-30.

Codex Alimentarius Commission (2005) Code of Hygienic Practice for Meat. CAC/RCP 58-2005.

Davies, P., Stärk, K.D.C. (2006) Disease surveillance in swine populations. In Diseases of Swine. Straw, B.E., Zimmerman, J.J., D'Allaire, S., and Taylor, D.J. (eds). Ames, Iowa: Blackwell Publishing, pp. 1099-1105.

Edwards, D. S., Johnston, A. M. & Mead, G. C. (1997) Meat inspection: an overview of present practices and future trends. *Veterinary Journal* **154**, 135-147

Food Science Australia & Minter Ellison Consulting (2002) National risk validation project. NSW Department of Health, Sydney, New South Wales.

Hagan's (1973) Infectious Diseases of Animals 6th Edition. Editors Bruner, D.W. and Gillespie JH. Cornell University Press, London.

Hamilton, D., Gallas, P., Lyall, L., Lester, S., McOrist, S., Hathaway, S. and Pointon, A. (2002) Risk-based evaluation of post mortem inspection for pigs in Australia. The Veterinary Record **151**(4): 110-116.

Hathaway, S. C. & McKenzie, A. I. (1991) Postmortem meat inspection programs; separating science and tradition. Journal ofFood Protection **54**,471-475

Horchner, P.M., Brett, D., Gormley, B., Jenson, I. & Pointon, A.M. (2006) HACCP-based approach to the derivation of an on-farm food safety program for the Australian red meat industry. Food Control, **17**, 497-510.

Jackowiak, J., Kiermeier, A., Kolega, V., Missen, G., Reiser, D, Pointon, A.M. (2006) Assessment of producer conducted antemortem inspection of market pigs in Australia. *Australian Veterinary Journal.* **84**(10):351-357.

Jubb, K. V. S. & Kennedy, P. C. (1963). Pathology of Domestic Animals. Academic Press New York. Vols 1 & 2.

Knappen van (1997) The Ruwenberg Conference. World Congress on Meat and Poultry Inspection in the Next Century. June 1997. The Netherlands, Ministry of Agriculture, Nature Management and Fisheries. Pp. 40-45.

Meat and Livestock Australia (2003a) Through-chain risk profile for the Australian red meat industry. Part 1. Risk profile. PRMS.038c. Meat and Livestock Australia, Sydney. ISBN 1 740 363 71X.

Meat and Livestock Australia (2003b) Through-chain risk profile for the Australian red meat industry. Part 2: Technical information. PRMS.038c. Meat and Livestock Australia, Sydney. ISBN 1 740 363 728.

Mousing, J., Kryval, J., Jensen, T. K., Aalbaek, B., Buttenschon, J., Svenmark, B. & Willeberg, P. (1997): Meat safety consequences of implementing visual post-mortem meat inspection procedures in Danish slaughter pigs. *The Veterinary Record* **140**, 472-475

Pearce, B., Langbridge,J., Cobbold, R. and Glanville, R. (2009) Current activities add little to food safety. *Fleischwirtschaft International* **1**: 46-48.

Pointon, A.M., Hamilton. D., Kolega, V. & Hathaway, S. (2000) Risk Assessment of Organoleptic Post Mortem Inspection of pigs in Australia. *The Veterinary Record*. **146**: 124-131.

Pointon, A., Sumner, J., Delaere, I. and Slade, J. (2007) Information, Collation and Review of Risk Assessments on Meat and Meat Products. FSANZ Final Report.

Pointon, A., Kiermeier, A. & Fegan, N. (2012) Review of the impact of pre-slaughter feed curfews of cattle, sheep and goats on food safety and carcase hygiene in Australia. *Food Control*. **26**: 313-321.