Meat Food Safety Scheme

Periodic review of the risk assessment

Amended June 2014

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Disclaimer

This report was prepared for the New South Wales Food Authority at their request.

The report is based on discussion with Mr Bruce Nelan of the NSW Food Authority, documents provided by Mr Nelan, relevant refereed scientific papers and reviews from the published literature, and relevant reports from government, industry and standard setting agencies.

The author has assumed that:

- the scientific papers used as sources of information accurately represent the findings of the research carried out under the conditions described in the papers.
- the scientific reviews, government and industry reports used as sources of information accurately reflect the state of knowledge at the date of their publication.

The report has been prepared with due care and attention to accuracy. The author accepts no liability if, for any reason, the information contained in the report is inaccurate, incomplete or out of date. Any errors in the reporting or analysis of facts are unintended.

The author will not be responsible for the consequences of any actions taken or decisions made on the basis of any of the information, conclusions or recommendations contained in this document.

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Executive summary

The risk assessment of the Meat Food Safety Scheme was published in 2009 (2009 RA) to support the review of the New South Wales Food Regulation 2004 and is required to be revised at 5-year intervals, alternatively as a full risk assessment or an update. An update of the 2009 RA is reported here. The 2009 RA was reviewed and new or updated information was identified following the expert review of the 2009 RA and by undertaking an environmental scan for issues related to meat and meat products that have impacted meat food safety since 2009. Information sources included published foodborne illness reports in Australia attributed to meat, research findings related to hazards in meat production and processing and health risks, emerging issues in the farm to consumer continuum for meat relevant to health risk, international issues arising from human illness or perceived hazards linked with meat, border detentions for meat and meat products, findings of similar risk assessments of meat and meat products in Australia or internationally (including the Australian Primary Production and Processing Standards for Meat & Meat Products P1014), and any other relevant sources if identified during the above activities.

The main findings of the 2009 RA remain essentially the same although the supportive evidence is updated and further information is now available through the work of the New South Wales Food Authority (NSW FA) and others.

The hazard identification was largely supported by similar studies undertaken by Food Standards Australia New Zealand (FSANZ) for the 4 main meat species, The FSANZ hazard assessment of the minor and wild game meat species has been used to fill the information gap for this group. Additional hazards that have been identified as they are a concern or under investigation and included in the review were antimicrobial resistant bacteria (AMR), including multi-drug resistant Salmonellas, and *Clostridium difficile*.

The data supporting the exposure assessment has been updated and supplemented, namely:

- Australian consumption data of meat species and products where overall the rates were lower than in the 2009 RA. Specific age and sex differences in consumption were noted. Poultry and poultry products and dishes were most commonly consumed and consumption has increased together with pig meat compared with red meats. Production volumes of minor species and wild game meat are much lower than the main species and a significant amount is exported.

The following summarises the update of the hazard characterisation:

- The proportion of foodborne illness outbreaks between 2009 and 2010 and between 2011 and the 3rd quarter 2012 attributed to meat and meat containing dishes was low, less than about 3%. Of these, chicken and chicken containing dishes were the most common. Restaurants were the most common outbreak setting, *S. enterica* (35-37%) the most common microbial hazard and Typhimurium the most common *Salmonella* serotype with common genotypes in time periods and in the same locations. *Campylobacter* (13–14%) was the next most common, predominately linked with chicken. *C. perfringens* continues to be a cause of outbreaks in roast meat and meat dishes. Norovirus (complex foods, 5%) and an outbreak of *Listeria monocytogenes* (cold meat), *Staphylococcus aureus, Yersinia enterocolitica* (roast/BBQ pork) were responsible for outbreaks.

Notable reports in Australia and internationally to be considered by risk managers include:

- *S.* Typhimurium cases with increased disease severity; the strain present in chicken grower flocks.
- Shiga toxin-producing *E. coli* (STEC) infection outbreak attributed to consumption of kangaroo meat.
- Campylobacteriosis outbreaks linked with chicken (one duck) liver paté and parfait in foodservice settings in England; 7 outbreaks occurred between 2008 and 2012 in Australia.
- O157 STEC outbreaks attributed to mechanically tenderised and moisture infused beef in North America.

- Baseline levels of contamination of hazards in meats have been updated or identified as follows:
  - Red meat update with slightly higher prevalence rates of microbial indicators reported in 2011; believed due to poor weather conditions flagging the importance of climate and location on bacterial loads on incoming stock.
  - Inclusion of pathogen levels on chicken carcasses post-spin chill for NSW and nationally.
  - Inclusion of New Zealand data on contamination of chicken livers and mechanically removed chicken meat.
  - Limited data identified on pig meat that was not available in the 2009 RA.
  - Inclusion of NSW FA survey of microbial status of retail game meat
  - Inclusion of NSW FA survey of sulphur dioxide levels in retail meats; a very small although concerning number of samples of sausages and mince had levels in excess of the NSW permitted levels and this is being addressed by the Food Authority.
- National recalls and failures of imported food at border control 2010–2014:
  - These were mainly due to microbial contamination and *L. monocytogenes* presence in processed meats. The revised microbiological limit in the Food Standards Code for *L. monocytogenes* will provide a risk based approach in the future.

In addition to the risk characterisation of the 2009 RA, recent national and international quantitative RAs provide insight into risk management of meat hazards and recently recognised pathogen-product combinations have been flagged for their known or potential risks that should be considered by the risk managers. Important among these were:

- Through-chain model of foodborne pathogens in beef and pork in the EU emphasise the need for multiple interventions through-chain rather than single intervention at one point.
- USA model of *L. monocytogenes* and deli meats used to identify key management practices with greatest reduction in the risk of listeriosis.

- Poultry livers and dishes have been popularised and non-intact meat cuts likely to increase in production volume; pathogens can be internalised and protected from decontamination and inactivation resulting in an increased risk; education and advice to consumers and chefs on cooking and temperatures should be provided as appropriate.

The comments on the risk characterisation remain valid as do the comments of the external reviewer. The risk ranking relies heavily on previous studies with the population size adjusted for NSW. It is recommended that this is subject to a full revision based on NSW at the next review with the addition of meat products and hazards as evidence in this update or in the intervening period.

Introduction

A risk assessment of meat and meat products was undertaken in 2009 as part of a comprehensive review of the Meat Food Safety Scheme during the review of the Food Regulation (2004). Regulation reviews are programmed every 5yr. These reviews are underpinned by risk assessments, alternatively as an update or a full risk assessment. An update of the risk assessment for the Meat Food Safety Scheme is provided here.

The risk assessment completed in 2009 (referred to in the report as 2009 RA) was subject to external review. The reviewer drew attention to a number of weaknesses and made editorial suggestions for clarity and accuracy. Some of those weaknesses are addressed below but others will be considered when the full RA is undertaken.

This report provides an update and additional information available since the 2009 RA under the major headings of the 2009 RA report.

Update of the 2009 assessment

Approach taken

The approach used was the same as that the one for the previous update of the Seafood Safety Scheme and included:

- Consideration of the expert review of the 2009 Meat Food Safety assessment and completion of any of the more significant pieces of work not already addressed.
- Undertaking an environmental scan to identify issues related to meat and meat products that have impacted meat food safety since 2009. The sources included published reports between 2009 to date on the following:
  - Outbreaks of foodborne illness in Australia attributed to meat.
  - Research findings related to hazards in meat production and processing and health risks.
  - Emerging issues in the farm to consumer continuum for meat relevant to health risk.
  - International issues arising from human illness or perceived hazards linked with meat.
  - Border detentions for meat and meat products.
  - Findings of similar risk assessments of meat and meat products in Australia or internationally including the Australian Primary Production and Processing Standards for Meat & Meat Products P1014.
  - Other relevant sources if identified during the above activities.

  The findings have been reported under the heading of the 2009 RA in keeping with the RA process.

Hazard identification

Meat

Since publication of the 2009 RA, FSANZ has conducted a study of the microbial hazards associated with the four main meat species (Supporting Document 2) and with minor and wild game meat species (Supporting Document 3), and a chemical risk profile of meat and meat products (Supporting Document 4) to support Proposal P1014 – Primary Production & Processing Standard for Meat & Meat Products (Available from FSANZ, accessed 14/05/14, at http://www.foodstandards.gov.au/code/proposals/pages/proposalp1014primary5331.aspx). There is agreement between the 2009 RA and the FSANZ assessments for the four major species and, while additional microbial hazards were included in the FSANZ hazard assessment, there was limited or no evidence for the importance of these in Australia.

The following are additional or specific hazards identified.

Clostridium difficile

Within the clostridial group, *C. difficile* is distinguished from *C. perfringens* that is commonly associated with meat and meat dishes, as the epidemiology and control measures may be different, although as yet unclear. *C. difficile* is known as a highly infectious intestinal spore-forming bacterium some of which are toxigenic and able to cause protracted hospital-acquired diarrhoeal illness usually associated with antimicrobial therapy (Hoover & Rodriquez-Palacios, 2013). As community-acquired cases have been increasing foodborne transmission is considered one of the potential transmission vehicles although this remains speculative at present. In Australia, *C. difficile* has been found in cattle, sheep and pigs with higher prevalence in the younger animals although the genotypes were different from the epidemic hypervirulent genotypes of major clinical significance in the Northern Hemisphere (Knight and Riley, 2013; Knight et al, 2013). Faecal carriage of *C. difficile* in sheep, lambs and cattle were low while calves were significantly higher. The bacterium was not detected in carcass washings from adult cattle in Western Australia (Knight et al, 2013). Piglets that are susceptible to *C. difficile* disease have the highest prevalence rate of the major meat species animals (Squire et al. (2013).

Antimicrobial resistant microorganisms

Antimicrobial resistant microorganisms (AMR) are a global concern as the efficacy of antimicrobials for treatment of human infections, as well as animal infections, are becoming critically limited due to the acquisition of resistance among pathogens and a lack of new antimicrobials being developed (WHO, 2014). Of critical importance are of the fluoroquinolone and third-generation cephalosporin classes of antimicrobials. While much of the AMR may result from use and abuse of antimicrobials in human medicine, AMR can originate also on the farm as a result of imprudent use of antimicrobials to treat animals therapeutically or prophylactically. Both foodborne zoonotic bacteria and commensals can be AMR which, if transferred to humans in food, can result in failure of clinical treatment of infections and potential transmission of AMR to human microflora. While management is primarily on farm, AMR should be controlled along with other hazards in the food chain and their presence should be monitored along with animal and human AMR surveillance (Anon, 2013).

Australia has been pro-active in the management of antimicrobial use in food production animals and there are processes in the food chain that will minimise their presence along with other microbial contaminants (Anon, 2013). Antimicrobial use in farm animals was summarised at a recent Australian One Health Antimicrobial Resistance Colloquium as follows:

- Poultry: use very limited; no cephalosporins or fluoroquinolones registered for use; those used more commonly are tetracyclines and sulphonamides.
- Pigs: widespread use; currently being addressed by industry as multi-drug resistant isolates have been found in Australian pigs; commonly used antibiotics include oxytetracycline, erythromycin, lincomycin, olaquindox and amoxicillin.
- Cattle/sheep: significant antimicrobial use for disease control, particularly in the more intensive practices of feed-lotting and dairy farming; limited AMR data currently available, current being studied by MLA; Ceftiofur, a third-generation cephalosporin is registered for use in cattle; usage needs to be prudent and monitored; in-feed use in both cattle and sheep (e.g. ionophores, macrolides (e.g. tylosin) and virginiamycin.

The presence of AMR may vary between meat producing species. *S. enterica* (n=165) isolated from clinical infections in food animals in NSW, 2007–2011, were screened for susceptibility to 18 antimicrobials (Abraham et al, 2014). They had a comparatively favourable resistance status and no resistance to fluoroquinolones or third-generation cephalosporins important in human medicine was detected.

All *Salmonella* strains received by the Microbiological Diagnostic Unit for serotyping are routinely tested for resistance to twelve antibiotics**.** In 2013, 26% of 600 isolates from farmed animals and 7% of 263 isolates from human food had resistance to ≥1 antimicrobial (NEPSS, pers. comm., 2014). Six of 154 isolates from farmed animals had resistance to 9 antimicrobials tested. Human food isolates had resistance to up to 4 antimicrobials and one to 7 antimicrobials. Particular serovars were frequently resistant and are of predominantly porcine origin:

- *S.* Derby — 9/9 porcine isolates resistant
- *S.* Johannesburg — 10/25 porcine isolates resistant
- *S.* London — 6/8 porcine isolates resistant
- *S.* Rissen — 10/17 porcine isolates resistant
- m*S.*Tm PT193 — 137/139 isolates resistant (mostly bovine and porcine)

Game meat and minor meat species

The FSANZ hazard assessment provided an extensive review of the minor meat species (deer, camel, buffalo, emu, ostrich, crocodile and rabbit) and wild game species (wild boar, mutton birds, wallaby and kangaroo). The main microbial hazards identified are summarised in **Table 1** which is additional to the 2009 RA.

Table 1: Microbial hazards associated with minor meat species and wild game species. Data summarised from FSANZ Call for Submissions Supporting Document 3 to Proposal P1014 PPPS for Meat & Meat Products

Microbial hazard	**Comments**
Pathogenic *E. coli*, *Salmonella* (non-typhoid)	Principal hazards in all species except crocodiles (*Salmonella*) and mutton birds (no data); variation between species, locations and farmed or wild
Campylobacter jejuni, *C. coli*, *Listeria monocytogenes*, *Yersinia enterocolitica* and *Y. pseudotuberculosis*, enterotoxin producing Staphylococcus aureus, pathogenic *Aeromonas* spp.	*Aeromonas* spp. on processed carcasses of farmed rabbits in EU.
Toxoplasma gondii	Deer, camel, rabbit, kangaroo and wild boar populations with wide variation between countries
Trichinella spiralis	Not been detected in Australia
Hepatitis E virus (HEV)	Wild deer and pig in Europe and Asia; limited serological evidence of infection in Australia

In the FSANZ chemical risk profile for these species it was concluded the hazards were generally well controlled under existing extensive regulatory and non-regulatory measures. For this group attention was drawn to hazards with areas of uncertainty and the need for further research and monitoring of some hazards and these should be noted, for example:

- residues relating to the off-label usage of veterinary therapeutics for minor species,
- naturally occurring toxins, and
- biological and chemical substances that are regulated by the APVMA that could be potentially used for other purposes and ultimately be present as a contaminant in feed, for example, which is not regulated by the APVMA.

Exposure assessment

Consumption of meat

An Australian Health Survey was conducted in 2011–2012 (ABS, 2014). In the first report available at the time of writing, the proportion of people consuming meat, poultry and game products and dishes was available, although not the consumption volume. Around 7 out of 10 people consumed a food in this category on the day prior to interview and this provided 14% of their total energy intake (**Table 2**). Within this food category, chicken was most commonly consumed as 17.8% had eaten a piece of chicken and a further 14.3% had eaten a dish containing chicken. Beef alone was consumed by 12% and beef in a dish consumed by 9%. 22.2% consumed processed meats of which ham was the most common (12%). Sausages were consumed by 7.2% and lamb and bacon were each consumed by 5% of the population. The age categorization groups in the survey were shifted by a year compared with the 1995 survey in the 2009 RA. However, overall the rates were lower in 2011–2012 (see Appendix 1,**Table 14**).There were differences in consumption rates between the sexes as in the previous survey. In particular, about twice as many females aged 2 to 13 years compared to males had eaten chicken and feathered game.

Table 2: Proportion of Australian population over 2 years old consuming meat, poultry and game products and dishes in 2011–2012. (Data taken from Australian Health Survey 2011–2012, ABS, 2014).

Meat, poultry and game products and dishes	% total population ≥ 2 years
1. Beef, sheep and pork, unprocessed	21.4
2. Mammalian game meats	0.2
3. Poultry and feathered game	17.8
4. Organ meats and offal, products and dishes	0.3
5. Sausages, frankfurt's and saveloys	7.2
6. Processed meats	22.2
7. Mixed dishes with 1 & 2 above as the major component	11.9
8. Mixed dishes with 5 & 6 above as the major component	0.2
9. Mixed dishes with 3 above as the major component	14.3
Total proportion consuming this food group	69.3

The apparent consumption of the main meat species per person in Australia was reported by ABARES (2013). Between 2010 and 2012, poultry meat was consumed in the highest volume, increasing in each year, and was significantly higher than the other main species that decreased slightly or remained unchanged (**Table 3**).

Table 3: Apparent consumption per person of main meat species in Australians, 2010–2012. (Data source ABARES, 2013).

Year	Apparent annual consumption per person (kg)			
	Beef & veal	Lamb & mutton	Pig meat	Poultry meat
2010	34.9	10.2	25.8	40.8
2011	32.8	9.2	25.0	43.3
2012	32.2	9.9	26.3	44.0

In 2013, Australia was the largest consumer of chicken meat on a per capita basis and is predicted to remain Australia's most consumed meat over the medium term (Mifsud, 2014). Chicken is on average 21%, 22% and 45% cheaper than pork, beef or lamb, respectively. Australian chicken meat consumption is forecast to rise by 1% in 2013–2014 to 44.7 kg/person, a further 1% in 2014–2015 to 45.2 kg /person, and with projections to 47.7 kg/person by 2018–2019. The Australian Chicken Meat Federation Inc. reported in 2011 that free range chickens represent around 15% of the total market (ACMF, 2011). Based on ABARES data, consumption of beef is also expected to rise to 33.8 kg per person in 2016–2017 and then fall to 31.3 kg/person by 2017–2018 (Langley, 2013). A small increase in lamb consumption of 0.1 kg to reach 9.6 kg/person in 2017–2018 is predicted. Pig meat consumption increased 20% over the decade to 2011–2012 to 25 kg/person (it was 26 kg/person in 2012) and expected to reach 27 kg/person by 2017–2018. Importation of pig meat was expected to increase to 9% by 2013–14 and imports constitute a significant proportion of domestic sales. Imported pig meat must be directed for cooking in Australia at a processing establishment that has entered into an agreement under Section 66(B) of the *Quarantine Act, 1908*.

Indications of production volumes of game meats were estimated by FSANZ in development of P1014, Minor Meat Species, Supporting Document 4 – a brief description of the industries being assessed. Available from FSANZ, accessed 14/05/14, at http://www.foodstandards.gov.au/code/proposals/documents/P1014%20Minor%20Meat%20Species%20_%20Game%20PPPS%201CFS%20SD4%20Industries.pdf and are summarised in **Table 4**. Volumes are lower than the main species and a large proportion is exported.

Table 4: Production volumes of minor meat and wild game species in Australia. Data summarised from FSANZ Call for Submissions P1014 Minor Meat Species, Supporting Document 4.

Species	Annual production volume estimate (tonnes)	Species	Annual production volume estimate (tonnes, birds)
Buffalo	27; manufactured into smallgoods, sausages, hamburgers in NT	Emu	Not estimated
Camel	250; mostly exported	Kangaroo	21,000; 70% exported
Deer	288; >65% exported	Wallaby	135.8; export volume not recorded
Rabbit	260; 60% exported	Mutton birds	200,000 birds most domestic in Tasmania
Crocodile	100	Wild boar	1,838 (2007) most exported
Ostrich	30; 100% exported		

Hazard characterisation

Foodborne illness and meat and meat products

Update 2009–2012

Meat and meat related dishes have continued to be implicated in outbreaks of foodborne illness in Australia during 2009 to 2013 (Data from OzFoodNet Working Group Annual Reports, 2009 and 2010 and from Quarterly Reports 2011 to 09/2012). However, it was difficult to make comparison with earlier years and to collate data from these reports as the methodology and data presentation in the reports differ and the data in the Quarterly Reports is provisional. Therefore it was deemed necessary to report the results collectively for the report types. Categorization of responsible food vehicles or commodities in particular varied between reports so all entries that included a meat species, alone or in a complex food(s), was extracted. It is acknowledged that this may over-estimate the role of meat species as a source of the pathogen.

In the Annual Reports, it was noted in the analysis of 2010 data that attributed food vehicles were categorized into 18 types according to Painter et al (2009) with the addition of lamb. For 2009 the method used was not stated although the terminology appears different. There were also differences in the designation of foods with the headings ‘responsible vehicles’ and ‘vehicle category’ in 2009 and ‘food vehicle’ and ‘commodity’ in 2010. Where foods were classified as ‘suspected’ meat or chicken in 2009, in 2010 they appear to be listed as ‘unassigned’ and the designation of ‘suspected’ appears inconsistent between columns. For an outbreak in Victoria in November 2009 in an aged care facility, the food vehicle is ‘unknown’ although it is listed in the meat and meat containing dishes vehicle category. This may be an error. In the Quarterly Reports a food responsible was listed and not yet categorised.

A list of meat related outbreaks reported in 2009 and 2010 is provided in Appendix 2, **Table 15**, specifying the different reporting approaches and including outbreaks where a meat of any species was assigned and where meat was mentioned although suspected only. In 2009, 163 foodborne illness outbreaks were reported and a food was assigned in 69 (42%). Five (3% total) outbreaks were categorized as attributed to meat or meat containing dishes (M/MCD) although 2 of these were categorized as ‘suspected’ or ‘probable’ in the ‘responsible vehicle’ column; 2 were categorized as suspected M/MCD (1.2% total), one of which was chicken/pork rolls that may have included contaminated condiments. Three (1.8% total) were categorized as chicken and chicken containing dishes (C/CCD), 3 (1.8% total) were suspected chicken and/or eggs, and 3 (1.8% total) were mixed dishes/meals that included meat or chicken. The responsible vehicle for 2 of the M/MCD included pork as did one of the suspected and the mixed dishes; steak, bacon and beef burgers, and roast beef were suspected with other meal components in 3 respective outbreaks.

In 2010, 154 foodborne and suspected foodborne illness outbreaks were reported and a food was assigned in 43 (28%; **Table 15**). Using the different classification to 2009, a meat species was assigned the commodity responsible for 6 outbreaks only and these included lamb (1, 0.65% total), pork (1, 0.65% total) and poultry (4, 2.6% total). In 2 of the chicken commodity categorized outbreaks, the food vehicle was ‘possible’ or ‘suspect’. In addition, 21 outbreaks had meat of some species included in the list of food vehicles along with other ingredients or meal components although unassigned in the commodity list. Two of these were pork rolls where other non-meat contaminated ingredients may have been involved. ‘Chicken’ was included in 10 outbreak food vehicle descriptions, beef in 5, lamb in 3 and pork and bacon in 1 each, and the meat species were mixed in 5, although it is noted for each of these the contribution of meat species was not specified.

The outbreaks resulted in 182 affected persons and 4 hospitalizations in 2009, and 220 affected persons, 29 hospitalizations and 6 deaths in 2010. In a listeriosis outbreak in an unknown setting in February 2010, all cases were hospitalized with 4 fatalities. *Salmonella* Infantis was responsible for the 2010 outbreak in an aged care setting with 2 fatalities. Two hospitalizations were recorded in a campylobacteriosis outbreak attributed to steak and chicken liver pate while the remaining hospitalizations were reported in 10 salmonellosis outbreaks.

Restaurants were the most common outbreak settings in 2009 and 2010 (68.7% and 52.4% outbreaks respectively). Other identified settings were takeaways (5, 23.8% in 2010), a national franchised fast food outlet, bakeries (2 in 2009), and aged care facilities (2 in 2009) in each year and an institution in 2010. Seven of the 16 outbreaks in 2009 and 17/21 outbreaks in 2010 analyzed here occurred in New South Wales.

S. enterica was the most common microbial hazard identified in food vehicles with inclusion of meat species in 2009 (6/16, 37.5%) and 2010 (7/21, 33.3%). Chicken was listed in 4, pork in 2, and beef and bacon in one of the *S. enterica* outbreaks in 2009 and in 2010 chicken was listed in 3 and pork in 4 (2 pork rolls) outbreaks. Serotype Typhimurium was the most common serotype reported in each year. In 2009*, S*. Typhimurium was responsible for 5/6 outbreaks, all in NSW, with suspected responsible vehicles containing different meat species e.g. chicken, chicken/eggs, pork, chicken/pork and bacon and beef. In 4 outbreaks, 2 in January 2009 and 2 in March 2009, the strains had the same phage type, PT170, that was the most frequently reported Typhimurium phage type in human infections in Australia in 2009 and 2010 (NEPSS, 2010). Three of the PT 170 strains had the same MLVA 3-9-7-13-523 pattern although different meat species were suspected in each. PT 170/108 was responsible for a further 2 outbreaks in NSW in June and December 2010 where a chicken meal and pork rolls were suspected. PT 9 was reported in outbreaks in January 2010 and March 2010 in a takeaway and in a national franchised fast food outlet, with a pork bun and chicken pieces suspected.

In 2010, *S.* Infantis was responsible for an outbreak in a NSW aged care setting, suspected to have been transmitted by fluid thickener contaminated with raw chicken.

Campylobacter spp. (2009, 2/16, 12.5%; 2010, 3/21, 14.29%) were the second most common agents responsible. The food vehicles were listed as chicken with an exception where steak with chips and salad was the food vehicle. *Clostridium perfringens* was responsible for 2 outbreaks in 2009 and one outbreak in 2010 and sweet and sour pork and roast beef with vegetables and gravy were the suspected food vehicles in 2009 and rotti lamb curry attributed in 2010. Other agents included Norovirus, responsible for an outbreak in each year and with a Caesar salad with roast chicken food vehicle in 2009 and lasagne in 2010. The listeriosis outbreak in 2010 was linked with cold meat, species unspecified. *Yersinia enterocolitica* in BBQ pork or roast pork was reported in an outbreak in 2010. In other outbreaks the agents were not assigned.

Table 5: Outbreaks in 2009 and 2010 in Australia where meat, including all species, were attributed or suspected, the hazards responsible and the number of cases, hospitalisations and fatalities reported in the OzFoodNet Working Group Annual Reports (2010; 2012)

Agent responsible	Number of outbreaks (%)	Number affected	Number of hospitalisations	Number of fatalities
Salmonella enterica	13 (35.1)	130	25	2
Campylobacter spp.	5 (13.5)	72	2	0
Clostridium perfringens	3 (8.1)	60	0	0
Norovirus	2 (5.4)	40	0	0
Listeria monocytogenes	1 (2.7)	6	6	4
Yersinia enterocolitica	1 (2.7)	3	0	0
Unknown	10 (27.0)	75	0	0
Not further specified	2 (5.4)	16	0	0
Total	37	402	33	6

Table 6: Outbreaks in 2011 and up to September 2012 in Australia where meat, including all species, were attributed or suspected, the hazards responsible and the number of cases, hospitalisations and fatalities reported in the OzFoodNet Working Group Quarterly Reports

Agent responsible	Number of outbreaks (%)	Number affected	Number of hospitalisations
Salmonella enterica	13 (37.1))	158	21
Campylobacter spp.	5 (14.3)	41	1
S. enterica (2 serotypes) and *Campylobacter*	1 (2.9)	65	0
Clostridium perfringens	5 (14.3)	82	0
Norovirus	2 (5.7)	48	4
Staphylococcus aureus	1 (2.9)	38	1
Shiga toxin-producing *Escherichia coli*	1 (2.9)	5	1
Unknown	7 (20)	72	2
Total	35	509	30

Meat species were included in the responsible foods listed in 17.3% of 150 outbreaks in 4 quarters of 2011 and 10.6% of 113 outbreaks in the first 3 quarters of 2012 (Appendix 2, **Table 16).** These are provisional reports and the foods are not categorized as in the Annual Reports above and therefore should not be compared directly. There were 4 outbreaks attributed to rolls containing pork or chicken with raw egg dressings and these are not included as historically the raw egg has been the contaminant in these complex dishes. These were included in the 2009–2010 lists as in some instances they were categorized as CCDs. CCDs were attributed in 45.7% and chicken in 5% of the outbreaks where a food was listed in 2011-09/2012; meat (8.6%), MCD (14.3%), mixed meats (17.1%) and suspected meat (2.9%) were listed.

Notable in 2011–09/2012 were six outbreaks where patés or parfaits including poultry livers were attributed; 5 chicken liver and one duck liver. An outbreak of Shiga toxin-producing *E. coli* (STEC) gastroenteritis linked to game meat of kangaroo sp. was reported in the Northern Territory. The monophasic *S.* Typhimurium subsp I ser 4,5,12:i:- PT 193 was the responsible agent of the outbreak linked with homemade pork salami in Victoria. This strain is a particular concern as a consistent characteristic of this type is multi-resistance to antimicrobials important in human medicine (NEPPS, 2012).

In 2011–09/2012, there were 509 persons affected and 30 hospitalizations in the 35 outbreaks **(Table 6**). There were fatalities; however, as these were not described in the quarterly reports they are not analysed. Non-typhoid salmonellas were the most common agents responsible (37.1% total outbreaks), followed by *Campylobacter* spp. and *C. perfringens* (each 14.3%). *Campylobacter* spp. were linked with the poultry liver dishes and chicken kebabs. Two *Salmonella* serotypes and *Campylobacter* were detected in the duck liver parfait outbreak. Agents not recorded in 2009–2010 outbreaks were *S. aureus* in a mixed chicken meal and STEC in kangaroo meat.

Salmonella was the agent linked with implicated foods containing a range of meat species: 7 including chicken as a component, 2 pork smallgoods, a roast pig and a pork dish, and a burger and kebabs had components undefined. Typhimurium was the most common serotype (8/13 salmonellosis outbreaks) and others were Muenchen, Newport, Singapore (2) and type 4,5,12:i:-. Typhimurium PTs where listed included PT 9 (2), PT 135 (2), PT 170, PT 197; PT 9 and PT170 outbreaks were not in NSW in contrast to the preceding years.

Restaurants were the most common settings for outbreaks (42.9%) followed by commercial caterers (14.3%) and private residences (11.43%). Other settings were aged care, bakery, camp, temporary or mobile service, grocery/delicatessen (2), picnic, reception centre and takeaway (2). A quarter of the outbreaks nationally were in NSW.

Notable foodborne illness reports

S. Typhimurium

In WA in 2011 there was an increase in the number of notifications of human gastroenteritis caused by *S*. Typhimurium PFGE 39 that appeared to be more severe than other Typhimurium infections, with 26% of thirty-nine cases hospitalised, compared to 21% of other Typhimurium cases over the same period (Gov. WA, 2012). In December 2011, 1 case developed rhabdomyolysis[1], a serious and very rare complication of *Salmonella* infection, which resulted in

[1] Rhabdomyolysis is the breakdown of muscle tissue that leads to the release of muscle fiber contents into the blood. These substances are harmful to the kidney and often cause kidney damage.

acute renal failure. 88% and 82% cases had commonly consumed eggs or chicken respectively. During the same period the subtype was detected in retail chicken meat and in chicken grower flocks of which some had higher than normal mortality rates. The evidence suggested this strain may have enhanced virulence properties. A higher disease severity would impact on the risk ranking of such a strain.

Mono-phasic *S.* Typhimurium-like strains (m*S*. Tm; serotype *S*. subsp I ser 4,5,12:i:-) PT 193 was the cause of an outbreak in Victoria in 2011 and a homemade pork salami was attributed as the food responsible (**Table 16**). These strains are characteristically multi-resistant to antimicrobials (NEPSS, 2012).

Chicken liver paté and parfait

Campylobacteriosis outbreaks linked with chicken liver paté and parfait have been increasingly in frequency in Australia with at least 7 outbreaks reported between 2008 and 2012, all in restaurants or function centres (Merritt et al, 2011). Similarly in the United Kingdom, an increase in reporting of campylobacteriosis cases has been in part been associated with consumption of chicken liver paté or parfait prepared in catering settings (FSA, 2013). In 2011, over 90% of outbreaks of foodborne campylobacteriosis at restaurant and catering venues in the UK were linked with chicken liver paté made from undercooked chicken livers. Freezing and thawing livers at different temperatures and time were investigated as control measures and combinations were found to reduce contamination by 2–3 log_{10}cfu/g. However, as up to 4 log_{10} cfu/g may be present in fresh livers this will reduce but not eliminate the bacterium in inadequately cooked products (Harrison et al, 2013). Cooking to an internal temperature of 70^0C for 2 minutes has been recommended as a control measure by FSANZ (2012).

Mechanically tenderized and moisture infused meat

At least 5 outbreaks of infection with Shiga toxin-producing *E. coli* O157 (O157 STEC) have occurred in North America between 2000–2012 where the attributed food was beef that had been needle or blade injected for tenderisation or marination (Catford et al, 2013). The processing of this type of products allows the internalisation of bacteria originating on the meat surface, in the infused liquids or marinades, on the needles or blades and in the processing environment, to be internalised in what would otherwise be intact cuts. While no outbreaks have been reported in Australia, anecdotally it is known that processors, butchers and retailers are preparing a variety of meat species cuts in this manner to enhance eating quality and in value adding, and that the production volume may increase. Australian Pork Limited has produced a 'Moisture Infused ('MI') Pork Program Certification Standards' for the pork industry to support the introduction of the new moisture infusion technology for their industry.

The Canadian government undertook a recent risk assessment of O157 STEC in mechanically tendered beef (MRB) in their country setting (Catford et al, 2013). They concluded that consumption of MTB was 5 times riskier than consumption of an intact steak cut and that by comparison consumption of ground beef was 1,500 and 7,300 times riskier than consumption of MTB and intact beef cuts, respectively. Labelling of this type of product and the inclusion of validating cooking instructions on the label have been proposed as a control measure in the USA and considered in Canada. However, there is an argument that the health risk is not high enough to justify the cost. More recent research on the inactivation of O157 STEC in MTB has resulted in a range of cooking conditions that can be used to produce a safe product e.g. turning steaks (2cm thickness) over at intervals at about 2 minutes while cooking to $\geq 60^0$C on an open grill and turning over once if the grill is covered (Gill et al, 2014).

The NSW FA webpage on safe cooking temperatures recommends cooking a steak to 63^{0}C and resting for 3 minutes for medium rare (Accessed 26/05/14 at http://www.foodauthority.nsw.gov.au/consumers/keeping-food-safe/cooking-correctly/#.U4LqgGdZqUk). Updating of this advice is recommended in light of these new findings. The APL MI Pork Program Certification Standards makes no reference to cooking their products.

Beef and sheep-meat

National surveys

National surveys of red meat reported by Meat & Livestock Australia (MLA) were summarised in the 2009 RA. A further survey was conducted by MLA of frozen boneless beef and sheep-meat and of beef (striploins and outsides) and sheep primals (legs and shoulders) in export registered establishments in the winter and summer of 2011 (MLA, 2012). The results for frozen boneless beef and sheep-meat and an historical comparison of baseline studies from 1992/4 to 2011 is provided in .

Table 7 for those microbial analyses that had comparable methodologies only. In the 2011 survey, the *E. coli* mean count ($\log_{10}$ cfu/g) was 1.32 and 1.51 for boneless beef and sheep-meat, respectively. Coagulase positive Staphylococci were isolated from 3.4% boneless beef (mean count 1.93 $\log_{10}$ cfu/g) and from 1.8% boneless sheep-meat (mean count 1.66 $\log_{10}$ cfu/g) samples. *Salmonella* and *Listeria* spp. were not detected in frozen boneless beef. *Salmonella* was detected in 3.1% boneless sheep-meat and *Listeria* spp., *E. coli* O157:H7 and *Campylobacter* spp. were not detected. The results of microbiological analyses of beef and sheep primals are presented in **Table 8.**

Table 7: Microbial indicator organisms in frozen boneless beef (n = 1,165) and sheep-meat (n = 551) at meat processing establishments under the jurisdiction of the Australian Government Department of Agriculture in 2011 and historical comparison of data. Data summarised from MLA, 2012.

Microbiological analyses	Year survey conducted and frozen boneless meat sampled							
	1993/4		1998		2004		2011	
	Beef	Sheep-meat	Beef	Sheep-meat	Beef	Sheep-meat	Beef	Sheep-meat
TVC* (mean $\log_{10}$ cfu/g)	2.77	3.47	2.62	3.30	1.28	1.85	2.22	2.80
E. coli prevalence (% detection)	7.8	17.8	1.2	8.5	1.1	4.3	2.1	12.5

*TVC = total viable count, 25^{0}C

In 2011, the pathogen prevalence was very low or they were not detected. Notable was an increase in the indicator bacteria, total viable count, 25^{0}C (TVC) and generic *E. coli* counts compared with previous surveys. This was thought to be the result of extreme weather conditions in the eastern states at the time, e.g. extreme rainfall and flooding. If this is the case, this flags the need for consideration of changes in climatic conditions and food safety management.

Table 8: Microbiological analyses of beef and sheep primals in 2011 at meat processing establishments under the jurisdiction of the Australian Government Department of Agriculture. Data summarised from MLA, 2012.

Microbiological analyses	**Beef**		**Sheep-meat**	
	Striploin (n = 572)	**Outside (n = 572)**	**Leg (n = 613)**	**Shoulder (n = 613)**
TVC* (mean $\log_{10}$ cfu/cm^2)	1.25	1.51	2.02	2.29
E. coli prevalence (% detection)	10.7	25.2	42.3	34.6
E. coli mean count ($\log_{10}$ cfu/cm^2)	-0.49	-0.26	-0.44	-0.63
Coagulase +ve Staphylococci prevalence (% detection)	7.7	8.4	4.2	5.2
Coagulase +ve Staphylococci mean count ($\log_{10}$ cfu/cm^2)	0.19	0.18	-0.21	0.34
E. coli O157:H7	nd#	nd	0.3	0.2
Salmonella (% detection)	nd	nd	2.8	0.8
Listeria spp. (% detection; cfu/cm^2)	0.2; 1	nd	0.2 ; 2	nd
Campylobacter (% detection)	nd	nd	nd	0.2

*TVC = total viable count, 25^{0}C; # nd = not detected in 300 cm^2 (*E. coli* O157:H7, *Salmonella* and *Listeria* spp.) and in 250 cm^2 (*Campylobacter*).

Contamination beef carcasses and ground beef

Cattle hides are considered to be the major source of contamination of beef carcasses with O157 STEC during dressing in abattoirs operating under regulatory control and they are also an important source of *Salmonella* compared with faeces and gut contents (Arthur et al, 2010). Minimising hide contamination pre-slaughter and operating procedures to minimise transfer are important control measures.

In the USA Government testing programs, the prevalence of salmonellas on beef carcasses is lower than that in ground beef in contrast to the reverse for O157 STEC even though regulatory control for each is similar (Loneragan *et al*, 2012). Salmonellas harbour in bovine peripheral lymph nodes where they are protected during carcass decontamination and are not excised during carcass dressing and this is considered a likely explanation for this anomalous situation. Various intervention strategies are being investigated although the biological processes involved in cattle are poorly understood. Minimising the environmental load of salmonellas to which cattle are exposed pre-slaughter, vaccination and treatments to reduce host carriage are options being investigated.

International risk assessment

Recently the EU has supported a project to study foodborne pathogens in the beef chain (by using a longitudinally integrated (fork-to-farm) approach (Buncic et al, 2014). The conclusion was that in the EU there was not any 'single intervention-single chain point' combination by which the pathogens would be reliably and entirely eliminated from the chain resulting in total prevention of pathogens in beef and products at the time of consumption. Rather a range of control interventions have to be applied at multiple points along the chain to achieve an acceptable final risk.

The Canadian Government revised their risk assessment of O157 STEC in beef by using systematic reviews and meta-analysis of data along the Canadian agri-food chain for beef. They concluded that a combination of on farm and processing interventions provided the greatest reduction in cases of illness following consumption of beef (Smith et al, 2013).

Pig meat

Baseline studies

No evidence of contamination of pig meat was available in the 2009 RA. Hamilton et al (2011) reported on a national baseline survey of culled sow meat, retail pork sausages and pork mince (**Table 9**). *Salmonella* was detected in all samples types and *Listeria* spp. in sow meat and sausages while STEC and *Campylobacter* were not recorded or detected.

Table 9: National baseline survey of processing indicators and microbial hazards of culled sow meat, fresh retail pork sausages and retail pork mince. Data summarised from Hamilton et al (2011).

Microbiological analyses	Sow meat (n = 101)	Sausages (n = 116)	Mince (n = 148)
TVC* (mean $\log_{10}$ cfu/cm^2)	4.1	4.3	6.2
E. coli prevalence (% detection)	42.6 (95% CI: 32.8-52.8)	16.4 (95%CI: 10.2-24.4%)	6.0
E. coli mean count ($\log_{10}$ cfu/cm^2)	1.28	0.65	Not recorded
Coagulase +ve Staphylococci prevalence (% detection)	Not recorded	3.4 (95% CI: 0.9-8.6%)	1.3
Shiga toxin-producing *E. coli* (STEC) (% detection)	nd#	nd	nd
Salmonella (% detection)	8.9 (95% CI: 4.2-16.2)	8.6 (95% CI: 4.2-15.3%)	1.5
Listeria spp. (% detection)^	14.9 (95% CI:8.6-23.3%)	16.4 (95% CI: 10.2-24.4%)	Not recorded
Campylobacter (% detection)	Not recorded	nd	2.7

*Total viable Count; # nd - not detected; ^ none exceeded levels of 100 cfu/g.

International risk assessment

A through-chain quantitative risk assessment was carried out on *Salmonella* and pork in Ireland (Anon, 2014). In that country setting, overall, the risk assessment model predicted a linear relationship between the level of *Salmonella* positive pigs coming into a plant for slaughter and the number of contaminated pork cuts at the end of the process, reflecting the potential for contamination of an individual carcass and cross-contamination between carcasses and the overall plant environment. Using their model and data, the critical points most efficiently reducing the occurrence of *Salmonella* in final pork cuts were final rinsing and chilling. It was concluded that *Salmonella* had the potential to enter and spread at all stages of the pork supply chain and therefore control must involve a farm-to-fork approach and that the utilisation of a combination of interventions was imperative with no single intervention likely to have a risk reduction impact in isolation.

Goat meat

The faecal and rumen carriage of *Salmonella* among 121 free-ranging feral goats destined for slaughter and subsequent carcass contamination was studied at 2 Australian abattoirs (Duffy et al, 2009). *Salmonella* was detected in faeces (46.3%), rumen samples (45.5%) and on carcasses (28.9%). The dominant serotypes detected were Saintpaul (31%), Typhimurium (13%) and Chester (11%).

Goats have been shown to carry O157 STEC with subsequent contamination of carcasses at a processing plant in the USA (Jacob et al, 2013). Prevalences of 11.1%, 2.7%, and 2.7%, were found in faeces, on hides and carcasses of meat goats, respectively. Multiple pulsed-field gel electrophoresis (PFGE) subtypes were identified among 49 O157:H7 isolates, some of which were present on multiple sample types or collection days.

Chicken meat

Retail chicken meat

The prevalence of *Salmonella* serotypes and *Campylobacter* spp.in samples of retail chicken meat in NSW in 2005 and 2006 was presented in the 2009 report. Subsequently, FSANZ reported a baseline study of the prevalence and concentration of *Salmonella* and *Campylobacter* spp. on poultry and poultry meat collected at 3 points in the supply chain, on farm (faeces), pre-slaughter (caecae) and post processing (chicken rinse post spin chill) in 2007 and 2008 in up to 4 jurisdictions (FSANZ, 2010). The sample sizes and the point of sampling differ between the 2 surveys and are not directly comparable although some trends were similar.

The on farm study was conducted in 233 sheds on 39 farms in WA, and *Salmonella* was detected in 46.8% (0.9% Sofia) and *Campylobacter* spp. detected in 64.4% sheds. Prior to processing, 636 caecal samples were collected at processors in WA and SA where *Salmonella* was detected in 12.7% (7.5% Sofia) with significant differences between states. *Campylobacter* spp. were detected at similar rates of 83.5 and 84.3%. A summary of the post-processing data which included also QLD and NSW is presented in more detail in **Table 10**. The prevalence of non-Sofia *Salmonella* in NSW and nationally was 21–22% and the mean concentrations were very low (0.01 cfu/cm^2). In contrast, *Campylobacter* spp. prevalence was 95.1% in NSW and 84.3% nationally although the counts were similar, e.g. approximately 5 cfu/cm^2. At the time of publication of the report in 2010 it was concluded these results were comparable with baseline studies in other countries, e.g. USA, Canada. However, both in Australia and other countries risk reduction strategies including on farm management and setting poultry processing performance targets are being implemented and this is expected to impact on these figures into the future. These parameters will need to be regularly revised to assess the success of risk reduction programs in the chicken poultry chain and the risk to the consumer.

Table 10: *Salmonella* (non-Sofia and Sofia) and *Campylobacter* spp. prevalences and counts from chicken carcass rinses post-spin chill between 2007 and 2008 in NSW and nationally. Data sourced from FSANZ, 2010.

	No. +ve (%)	95% CI	Mean count* (SE)	No. +ve (%)	95% CI	Mean count* (SE)
Salmonella	*Salmonella* non-Sofia			Salmonella Sofia		
NSW (n=246)	52 (21.1)	(16.2, 26.8)	-1.85 (0.05)	70 (28.5)	(22.9, 34.5)	-1/93 (0.04)
National (n=1,112)	246 (22.1)	(19.7, 24.7)	-1.99 (0.02)	168 (15.1)	(13.1, 17.3)	-1.99 (0.03)
Campylobacter spp.						
NSW (n=246)	234 (95.1)	(91.6, 97.5)	0.73 (0.03)			
National (n=1,104)	931 (84.3)	(82.0, 86.4)	0.71 (0.02)			

* $\log_{10}$ cfu/cm^2; SE = standard error

Chicken offal and mechanically separated meat

Chicken offal is readily available at retail together with whole chickens and pieces and mechanically separated meat (MSM) is processed for reformed chicken products. As these products have been implicated in human infections the microbiological status has been noted. FSANZ (2005) referred to a study of retail chicken livers in South Australia in 2002 where *Salmonella* spp. were isolated from 59% of samples, 50% of which were *S.* Sofia.

Chicken processing lines that were known to be, or likely to be, positive for *Campylobacter* were surveyed in New Zealand in 2010 (MAFF, 2011). Ninety-five samples of heart, liver, gizzard and neck were sampled and *Campylobacter* was countable in 86% of heart, 99% of liver, 97% of gizzard and 99% of neck rinsates. Results on carcasses were not a predictor for presence or counts on offal and the distribution of counts on offal differed between processors, possibly due to differences in processing lines. The median (5th to 95th percentile) of the counts were:

- Heart: Processor A, 2.5 (ND [not detected] to 4.7) and Processor B, 3.8 (2.1 to 4.9) $\log_{10}$ cfu/rinsate.
- Liver: Processor A, 3.8 (2.2 to 5.5) and Processor B, 4.5 (3.7 to 5.4) $\log_{10}$ cfu/rinsate
- Gizzard: Processor A, 3.3 (ND to 4.8) and Processor B, 3.9 (3.0 to 5.0) $\log_{10}$ cfu/rinsate
- Neck: Processor A, 4.1 (2.2 to 5.0) and Processor B, 4.0 (2.7 to 4.8) $\log_{10}$ cfu/rinsate

There was a strong positive correlation between counts on the external surface and internal tissues of liver and washing was not effective in removal of internal contamination.

MSM (n=145) was collected from 3 processors with countable *Campylobacter* spp. detected in 87, 66 and 33% samples and coagulase positive Staphylococci in 44, 2 and 36% samples at respective plants (MAFF, 2011). Median counts (5th to 95th percentile) $\log_{10}$ cfu/g *Campylobacter* were 1.74 (ND to 3.17), 1.18 (ND to 2.55) and ND (ND to 2.08) and coagulase-positive staphylococci in MSM at the three processors were ND (ND to 3.52), ND (ND to 1) and ND (ND to 2.72) log10 cfu/g.

Game meat

There was limited data on the microbiological quality of game meats in Australia at the time of the 2009 RA and FSANZ found little data to support their hazard identification to support P1014. The NSW FA conducted a survey of retail game meats and products, both frozen and chilled, between November 2011 and June 2012 (B. Nelan, pers. comm. 2014). These meats have different domestic production and sale volumes and the numbers of samples similarly varied according to availability. The results are summarised in **Table 11.** Kangaroo was the most common species. A buffalo sample had the highest TVC (7.75 mean $\log_{10}$ cfu/g) and emu meat the lowest 3.24 (SD 0.30) with overall counts of 6.15 (SD 1.74) mean $\log_{10}$ cfu/g. Kangaroo meat had the highest prevalence (74.14%) and count of *E. coli* (1.83 (SD 0.77) mean $\log_{10}$ cfu/g). *E. coli* was not detected in buffalo and emu meats and venison, and was detected in boar and rabbit meats, 1.25 (SD 0.60) and 1.52 (SD 0.76) mean $\log_{10}$ cfu/g.

Coagulase positive Staphylococci were present at greater than 2logs in kangaroo and rabbit meat. *Salmonella* was detected in the boar meat sample and 24.4% of the kangaroo meats; *L. monocytogenes* was detected in samples of boar (2), kangaroo (2) and rabbit (1) meat while *Campylobacter spp.* were detected only in a venison sample. It was observed that frozen samples including sausages had lower TVCs (4 mean $\log_{10}$ cfu/g) and chilled fillets had the highest (7.22 mean log10 cfu/g.

Table 11: Microbiological analyses of game meats in NSW retail outlets between 11/2011 and 06/2012.

Microbiological analyses	Boar	Buffalo	Emu	Kangaroo	Rabbit	Venison
	n=10	n=1	n=2	n=58	n=12	n=17
TVC* (mean log10 cfu/g (SD^))	5.19 (1.81)	7.75 (0)	3.24 (0.30)	6.26 (1.74)	6.36 (1.19)	6.42 (1.64)
E. coli ((% detection)	40	0	0	74.14	33.33	0
E. coli mean count (log10 cfu/g (SD))	1.25 (0.60)	NT#	NT	1.83 (0.77)	1.52 (0.76)	NT
Coagulase +ve Staphylococci (% detection)	0	0	0	8.62	16.67	5.88
Coagulase +ve Staphylococci count (mean log10 cfu/g (SD))	NT	NT	NT	2.22 (0.36)	2.48 (0.48)	NT
Salmonella (% detection)	10	0	0	24.14	0	0

L. monocytogenes (% detection)	20	0	0	3.45	8.33	0
Campylobacter (% detection)	0	0	0	0	0	5.88

*TVC – Total Viable Count, ^ SD- standard Deviation #NT – not tested

Based on the Australian Meat Standards Committee guidelines, 68% of all samples were classified under the marginal category for TVC and 18% marginal for *E. coli* counts.

In the FSANZ hazard assessment of meat minor species and wild game meat limited data was identified for kangaroo, crocodiles, wild boar/feral pigs and rabbits and overall they concluded these species were susceptible to the same pathogenic microorganisms as the major meat species (Proposal PP1014 Supporting Document 3, Accessed 19/05/14 at http://www.foodstandards.gov.au/code/proposals/Documents/P1014-Meat2CFS-SD3.pdf). They cited evidence from the *E. coli* and *Salmonella* Monitoring Program (ESAM) for export products of two wild game species (kangaroo and wild boar) and four minor species (camel, deer, emu and ostrich) for the period 2008 to 2010. During this time 96.9% (4884/5043) TVCs were within the acceptable range or better and 96% (4924/5130) of *E. coli* counts for all carcasses were classed as acceptable or better with only 0.6% (30/5130) deemed unacceptable. Overall prevalence of *Salmonella* spp. was 0.9% (31/3370), with all species except emu having one or more positive detections. Camel had the highest detection rate although the sample number was small: 7/64 (10.9%) in 2009 and 6/97 (6.2%) in 2010. *Salmonella* serotypes Anatum and Give were the most frequent. When compared to the results in Table 11, export product appears to be of higher microbiological quality than the domestic retail product.

There is some recent evidence of the prevalence of foodborne pathogens in game in the wild in Australia. *Salmonella* was found to be highly endemic in a remote wild pig population in 93 locations in tropical north-western Australia (Ward et al, 2012). The overall prevalence in 546 pigs was 36.3% (95% CI 32.1–40.7%) in faeces and 11.9% (95% CI, 9.4–15.0%) in mesenteric lymph nodes. Thirty-nine serotypes were identified and none of these was Typhimurium. STEC were found to be carried by native Australian marsupials studied in Southeast Queensland (Rupan et al, 2012). Rates of *stx* carriage by macropods (8.6%) were comparable, though generally low, when compared to cattle. Eastern grey kangaroos had the highest rate of *stx* positive faeces (10.3%) although based on possession of virulence markers and serotypes; the human pathogenic potential of isolates was low.

Processed meat products

Risk assessments

Following the ranking of deli meats as presenting the highest health risks of listeriosis among ready-to-eat (RTE) foods in the USA, a quantitative risk assessment was used to identify management practices in delis that would have the greatest impact on reducing the estimated health risk (USDA, 2013). The key practices identified were:

- control of growth of *L. monocytogenes* by use of growth inhibitors in suitable products and temperature control,
- control cross-contamination at retail,

- control contamination of incoming products at source,
- effective sanitation practices for food contact surfaces,and
- identify key routes of contamination for control, e.g. slicers.

L. monocytogenes was one of the significant microbial hazards of concern in processed meats outlined in the 2009 RA. Microbiological testing for this pathogen is a risk management tool used by regulators and industry to reduce consumer exposure via meat products. FSANZ has revised the microbiological limits of this pathogen in individually nominated foods including some meat products (e.g. packaged cooked cured/salted meat and heat treated meat paste and paté) to provide a broader, risk-based approach for RTE food groups, taking into consideration their physical and chemical characteristics and shelf life (FSANZ, 2014). This approach provides flexibility for manufacturers to produce different products and use different methods while meeting a required level of consumer protection. The categories and associated *L. monocytogenes* limits include:

- RTE foods in which growth of *L. monocytogenes* will not occur (<100 cfu/g).
- RTE foods in which growth of *L. monocytogenes* can occur (not detected in 25 g).

This is an important development in management of *L. monocytogenes* for processed meats.

Chemicals in meat

Sulphur dioxide is used as a preservative in some meats and the types of meat products and the amount permitted is specified in the Food Standards Code. In NSW it is permitted only in some processed meats, poultry and game products that are produced using comminuted meats and the amount permitted is less that 500mg/kg (NSW FA Permitted use of sulphur dioxide. Accessed 07/05/14 at http://www.foodauthority.nsw.gov.au/industry/food-business-issues/sulphur-dioxide/#.U2mybWdZqUk). It is not permitted in raw meat, poultry and game and is not permitted in raw minced meat of any kind. Meat products were sampled by the NSW FA between July 2007 and December 2013 and screened for sulphur dioxide using a field test and those that were positive were submitted for laboratory analysis. Approximately 9,200 retail meat premises were inspected in that period. The number of samples failing the field test was very low. Among the small number that was positive, approximately 21% of 201 sausage samples exceeded the limit of 500 mg/kg (range 10-4,004) and 58% of 107 minced meats (range 13-1,756) had sulphur dioxide detected. In the case of sausages it is acknowledged the limit may be exceeded minimally when pre-mixes are used. However, 28% were over 1,000 mg/kg (Figure 1) and the highest levels (>2,000) were detected in 2 samples labelled chicken and the other pork. While the number of positive samples is quite low strengthened enforcement action is being undertaken.

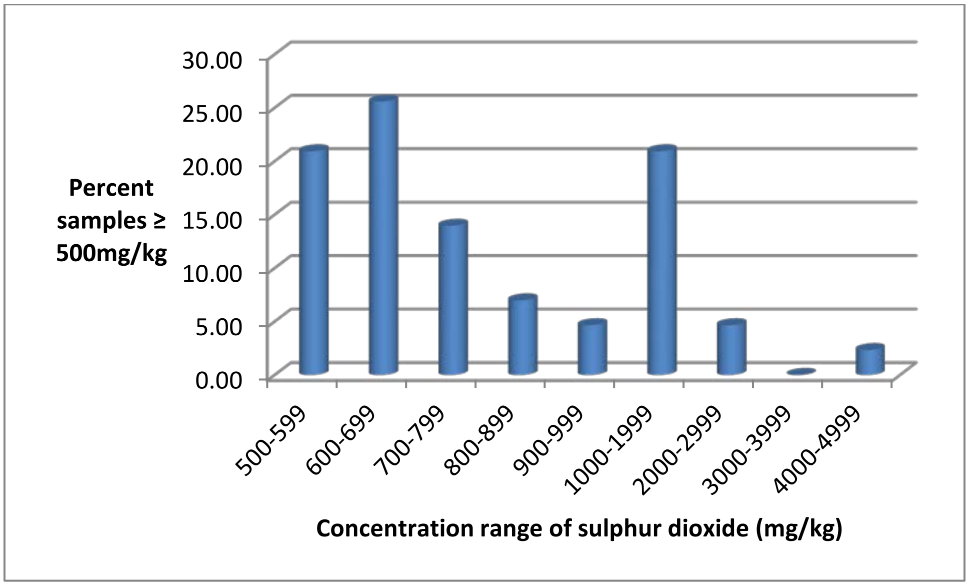

Figure 1: Concentration range of sulphur dioxide in 43 of 201 retail sausages failing the field test and submitted for laboratory analysis where the levels were ≥500 mg/kg. Sausages sampled in NSW, July 2007 to December 2013, by the NSW Food Authority.

Recalls and import border failures for meat and meat products

Analysis of consumer level recalls and retention of imported foods at Australia's borders provides some information on the foods and safety hazards that do or could enter the food supply from either domestic or imported food sources and pose a health risk. Ten consumer level recalls of meat and meat products in Australian States and Territories have been listed by FSANZ on their website between 2010 and 5 May, 2014 (Accessed 05/05/14 at http://www.foodstandards.gov.au/industry/foodrecalls/recalls/Pages/default.aspx) and are shown in **Table 12**. One recall was restricted to NSW and 3 were multi-state including NSW. Microbial contamination was the most common reason for recall (5/10, 50%), 3 due to *L. monocytogenes* and one due to *Staphylococcus*. Other causes were foreign materials (3/10, 30%) including plastic and rubber, an undeclared allergen (1/10, 10%) and faulty packaging material (1/10, 10%).

Two of the meats contaminated with *L. monocytogenes* were packaged sliced cooked meats and two (one sliced and one whole piece) were ham in vacuum packs. Fresh meats were recalled due to the presence of foreign materials (2/10, 20%) and the presence of an undeclared allergen in beef patties in one recall.

Table 12: Consumer level recalls of meat and meat products in Australia 2010- 04/2014. Data from FSANZ (Accessed 05/05/14 at http://www.foodstandards.gov.au/industry/foodrecalls/recalls/Pages/default.aspx)

Date	Location	Product	Outlet type	Reason	Notes	Packaging
07/2011	QLD	minced beef premium	SM*	FM	plastic	polystyrene tray with cling wrap
06/2010	VIC	minced beef	butcher	FM	natural rubber latex	no pre-pack
01/2012	QLD	chabi		MC	*Staphylo-coccus*	unpackaged
05/2012	NSW, QLD, ACT	cocktail frankfurts	SM	FM	blue plastic	unpackaged
11/2012	ACT	prager ham	Butcher, retail	MC	*L. mono-cytogenes*	shrink pack cryovac packet
05/2012	QLD	chorizo sausages	butcher	MC	*L. mono-cytogenes*	vacuum seal
06/2012	VIC	sliced leg ham	small independent SM	MC	*L. mono-cytogenes*	vacuum sealed
06/2013	NSW	sliced cooked corned beef	Deli store	MC	*L. mono-cytogenes*	CVC bags
01/2014	Australia wide	Micro-wave pies (beef, cheese & beef)	SM, retailer	packing material fault		plastic film packaging
02/2014	NSW, NT, QLD, SA, TAS, VIC	fresh beef patties	SM	un-declared allergen	gluten	MAP packed

*SM=Supermarket; FM=foreign material; MC=microbial contamination

Meat and meat products are imported under strict import rules and are inspected under the Imported Food Inspection Scheme (Department of Agriculture (DoA) website. Accessed 05/05/14 at http://www.daff.gov.au/biosecurity/import/food/inspection-scheme). Compliance tests applied to meat include BSE (bovine spongiform encephalitis) government certification, coagulase positive Staphylococci, *E. coli*, *L. monocytogenes*, *Salmonella* and Standard plate count and analysis of failures provides an indication of potential for importation of microbial hazards. Failing food reports are available on the DoA website accessed 05/05/2014 at http://www.daff.gov.au/biosecurity/import/food/failing-food-reports . Twenty-seven failures in the meat category between 2010 and February 2014 were analysed (**Table 13**). The most common reason for failure was the presence of *L. monocytogenes* in 11 cured ham products (40.7% total failed meats), 2 cooked meatballs and one semi-cooked duck liver. Four of the cured hams were specified as sliced. Seven samples (5 cured hams and the semi-cooked duck liver) had *E. coli* counts above acceptable limits and one had excessive coagulase positive staphylococci. A further 6 failed due to lack of BSE government certification.

It is noted these results were based on the Food Standards Code 1.6.1 at the time and as mentioned under the processed meat products section this is under revision.

Table 13: Failures of microbiological tests among imported foods 2010 to 03/2014. Data from Failing Food Reports accessed 05/05/14 at http://www.daff.gov.au/biosecurity/import/food/failing-food-reports

Product description	Number of failures	Country of Origin	Analytical test failed
cured ham	17	6 Italy, 12 Spain	5 E. coli, 11 *L. monocytogenes*, 1 coagulase +ve Staphlyococci
beef stock, cube	2	UK, Korea	2 BSE
cooked meatballs	2	NZ	2 *L. monocytogenes*
chilli paste with beef	1	China	BSA
chondroitin sulphate	1	China	BSE
corned beef	1	Argentina	BSE
frozen cooked chicken strips	1	NZ	*E. coli*
semi-cooked duck liver	1	France	*E. coli*, *L. monocytogenes*
soup containing beef	1	UK	BSE

Risk characterisation

The external reviewer noted that additional information was required on game meat and minor meat species. This is provided below but some other comments of the external reviewer remain and it is understood these will be addressed in a full RA to be undertaken at the next review.

Game meat and minor species

FSANZ in their risk assessment of minor species and wild game meat concluded there were no substantial differences in the human health risk posed between these species and the 4 main meat species on the following basis:

- Production. Minor species presented no greater risk that cattle; some wild game species presented a relatively higher risk as they are not subject to the same controls in husbandry practices, food and water.
- Processing. All species are subject to the same Australian Standards requirements at processing and minor differences may result depending on a plant's capability and design.
- Hazards. It appears the hazards are the same as the major species although data is limited on hazards in the meat and human illness.

2009 RA conclusions

The 2009 RA was subject to external review where data gaps were noted and questions were raised regarding the risk ranking. This update provides revised more recent data and additional data to fill some of the gaps identified and notes some additional issues that have arisen since publication of the 2009 RA. The main conclusions are as follows.

An additional hazard in the 4 main meat species is antimicrobial resistant bacteria, both pathogens and commensal bacteria that can be transmitted via meat and can result in clinical treatment failure. In a through-chain management approach control has to be exercised on farm with prudent use of antimicrobials in meat producing animals, together with the control of meat contamination in the subsequent steps in the meat food chain to minimise exposure. Specific *Salmonella* serotypes have been reported in farmed animals and human infections that have multiple drug resistance characteristics. An AMR of uncertain significance in meat is *C. difficile* particularly in community settings.

Hazards and health risks of game meat and minor species were not considered to differ from the 4 major meat species if processed in establishments employing the same level of food safety measures. Uncertainty exists for wild caught game not produced under the same conditions to minimise food safety risks. An outbreak of STEC infection was attributed to kangaroo meat.

Meatborne outbreaks occurred less often among foodborne outbreaks. When they occurred foodservice establishments were the most common setting and they are a target for improved management of safe food handling and preparation.

Chicken and chicken containing dishes were the meat species most commonly attributed in outbreaks. Chicken meat was the most common meat species consumed by Australians, with the volume/person increasing and differences occurring among consumer groups such as by age and sex. Reduction of prevalence and levels of *Salmonella* and *Campylobacter* in chicken meat and safe consumer handling is required to reduce health risks.

Two meat products of increasing interest – chicken or duck paté and parfait, and non-intact meat cuts (mechanically tenderised or moisture infused) – were the cause of *Campylobacter* and O157 STEC outbreaks nationally and internationally, respectively. Undercooking was the contributing factor and allowed the internalised bacteria to survive. Risk management of these products should be considered in educational material, e.g. safe cooking procedures and temperatures.

S. enterica was the most common agent responsible for outbreaks and Typhimurium the most common serotype. Specific Typhimurium genotypes predominate in niches periodically and there is epidemiological evidence for increased virulence and AMR in specific strains. The severity of disease for these strains will alter their risk ranking.

Updated evidence of hazard prevalence and levels along the meat chain further supports exposure assessments. The NSW FA surveys of retail game meat and sulphur dioxide levels provided data to fill gaps in the 2009 RA. The survey of sulphur dioxide revealed a very small prevalence of contamination in retail sausages and minced meats although, among those failing regulatory levels, some had concerning levels exceeding specified limits which has led to the Food Authority strengthening regulatory control.

Microbiological contamination was a major reason for product recalls nationally and failures of imported foods at border control. *L. monocytogenes* exceeded levels in the Food Standards Code at the time. The proposed risk-based microbiological limits for this bacterium should be adopted when finalised.

Conclusions from international RAs include:

- pathogen control for beef and pork includes multiple interventions through-chain rather than single interventions.
- risk reduction of *L. monocytogenes* in deli meats is greatest with use of growth inhibitors in products, control of incoming product contamination levels, sanitation and cleaning of contact surfaces and equipment and specific identification of transmission routes.

The risk characterisation had some limitations based heavily on RAs conducted elsewhere before 2009 and adjusted for NSW population numbers. Some risk ranking was questioned by the reviewer. These should be subject to a full risk assessment at the next review. Game meat and minor species not included in the 2009 RA have been assessed by FSANZ to present no greater risks than 4 main species.

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References

ABARES, 2013. Australian Commodity statistics 2013. Rural commodities meat general. Accessed 16/05/14 at http://www.daff.gov.au/ABARES/Pages/display.aspx?url=http://143.188.17.20/anrdl/DAFFService/display.php?fid=pb_agcstd9abcc0022013_11a.xml).

Abraham S, Groves MD, Trott DJ, Chapman TA, Turner B, Hornitzky M, Jordan D**.** 2014. *Salmonella enterica* isolated from infections in Australian livestock remain susceptible to critical antimicrobials. Internat, J. Antimicrob. Agents 43:126-130.

Anon, 2014. *Salmonella* in pork on the island of Ireland: A microbial risk assessment. Teagast, Dublin, Ireland. (Accessed 17/04/14 at https://www.safefood.eu/SafeFood/files/e6/e6af0e48-626d-4c04-ae05-0399964185b3.pdf).

Anon, 2013. Australian One Health Antimicrobial Resistance Colloquium Background Paper. Australian Commission on safety and quality in health care, July 2013.

Arthur TM, A, Brichta-Harhay DM, Bosilevac JM, Kalchayanand N, Schackelford SD, Wheeler TL, Koohmaraie KM. 2010. Super shedding of *Escherichia coli* O157:H7 by cattle and the impact on beef carcass contamination. Review Article. Meat Sci. 86:32-37.

Australian Bureau of Statistics (ABS), 2014. Australian Health Survey: Nutrition First Results – Food and Nutrients, 2011-2012 – Australia. Meat poultry and game products and dishes. Accessed 15/05/14 at http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/4364.0.55.007~2011-12~Main%20Features~Meat,%20poultry%20and%20game%20products%20and%20dishes~724).

Australian Chicken Meat Federation (ACMF) Inc., 2011. The Australian chicken meat industry. An industry profile. (Accessed 28/05/14 at http://www.chicken.org.au/industryprofile/downloads/The_Australian_Chicken_Meat_Industry_An_Industry_in_Profile.pdf).

Buncic, S, Nychas G-J, Lee MRF, Koutsoumanis K, Hébraud M, Desvaux M, Chorianopoulos N, Bolton D, Blagojevic B, Antic D. 2014. Microbial pathogen control in the beef chain: Recent research advances. Meat Sci. 97:288-29.

Catford A, Lavoie M-C, Smith B, Buenaventura E, Couture H, Fazil A, Farber JM. 2013. Findings of the health risk assessment of *Escherichia coli* O157 in mechanically tenderized beef products in Canada. Int. Food Risk Anal. J. 3(2). doi:10.5772/56713.

Duffy L, Barlow R, Fegan N, Vanderlinde P. 2009 Prevalence and serotypes of *Salmonella* associated with goats at two Australian abattoirs. Letts. Appl. Microbiol. 48:193-197.

Food Standards Agency (FSA), 2013. An evaluation of freezing as an intervention to reduce the numbers of campylobacters isolated from chicken livers. (Accessed 06/05/14 at http://www.food.gov.uk/science/research/foodborneillness/foodbornediseaseresearch/b14programme/b14projlist/fs101025/#.U2hl_WdZqUk).

FSANZ, 2014. Proposal P1017 – Criteria for *Listeria monocytogenes* – Microbiological Limits for Foods. (Accessed 29/05/14 at http://www.foodstandards.gov.au/code/proposals/pages/proposalp1017criteri5439.aspx).

FSANZ, 2012. Cooking poultry liver dishes safely. Accessed 06/04/14 at http://www.foodstandards.gov.au/consumer/safety/poultryliver/Pages/default.aspx.

FSANZ, 2010. Baseline survey on the prevalence and concentration of *Salmonella* and *Campylobacter* in chicken meat on-farm and at primary processing. (Accessed 12/05/14 at http://www.foodstandards.gov.au/science/monitoring/surveillance/pages/baselinesurveyonthep4998.aspx). Government of Western Australia, Department of Health, 2012.

FSANZ, 2005. Scientific assessment of the public health and safety of poultry meat in Australia. Attachment 3, November 2005.

Gill, CO, Devos J, Youssef MK, Yang X. 2014. Effects of selected cooking procedures on the survival of *Escherichia coli* O157:H7 in inoculated steaks cooked on a hot plate or gas barbecue grill. J. Fd. Prot. 77:919-926.

Government of Western Australia. 2012. *Salmonella* Typhimurium outbreak linked to chickens. Disease Watch, 16, issue 2. (Accessed 25/05/14 at http://www.health.wa.gov.au/diseasewatch/vol16_issue2/salmonella_typhimurium_outbreak_linked_to_chickens.cfm).

Hamilton D, Holds G, Smith G, Flint R, Lorimer M, Davos D, Kiermeier A, Pointon A. 2011. National baseline surveys to characterise processing hygiene and microbial hazards of Australian culled sow meat, retail pork sausages and retail pork mince. Poster abstract. 9th Internat. Conf. on the Epidemiology and Control of Biological, Chemical and Physical Hazards in Pigs and Pork. SafePork. 2011. Maastricht, The Netherlands. 9-22 June 2011.

Harrison D, Corry JEL, Tchorzewska MA, Morris VK, Hutchison ML. 2013. Freezing as an intervention to reduce the numbers of campylobacters isolated from chicken livers. Lett. Appl. Microbiol. 57:206-2013.

Hoover, DG, Rodriguez-Palacios A. 2013. Transmission of *Clostridium difficile* in foods. Infect. Dis. Clinics North America. 27:675-685.

Hoover, DG, Rodriguez-Palacios A. 2013. Transmission of *Clostridium difficile* in foods. Infect. Dis.Clinics North America. 27:675-685

Jacob, M E, Foster D M, Rogers AT, Balcomb CC, Sanderson MW. 2013. Prevalence and relatedness of *Escherichia coli* O157:H7 strains in the feces and on the hides and carcasses of U.S. meat goats at slaughter. Appl. Environ. Microbiol. 79:4154-4158.

Knight, DR, Riley TV. 2013. Prevalence of gastrointestinal *Clostridium difficile* carriage in Australian sheep and lambs. Appl. Environ. Microbiol. 79:5689-5692.

Knight, DR, Thean S, Putsathit SP, Fenwick S, Riley TV. 2013. Cross-sectional study reveals high prevalence of *Clostridium difficile* non-PCR Ribotype 078 strains in Australian veal calves at slaughter. Appl. Environ. Microbiol. 79:2630-2635.

Langley, S. 2013. Chicken meat most popular meat in Australian diet, new trends for other meats. AFN. June 12 . Accessed 15/05/14 at http://ausfoodnews.com.au/2013/06/12/chicken-meat-most-popular-meat-in-australian-diet-new-trends-for-other-meats.html.

Loneragan, GH, Brichta-Harhay, D, Edrington, T, 2012. Solutions for the food safety threat posed by *Salmonella* in the lymph nodes of cattle presented for harvest. Project Summary (funded by Beef Checkoff). Cited 20/08/13 at http://www.beefresearch.org/CMDocs/BeefResearch/Safety_Project_Summaries/FY11_Solutions_for_the_food_safety_threat.pdf.

Meat & Livestock Australia (MLA), 2012. Microbiological quality of Australian beef and sheepmeat. Results of the industry's fourth national abattoir survey, 2011. MLA, 2012.

Merritt T, Combs B, Pingault N. 2011 *Campylobacter* outbreaks associated with poultry liver dishes. Comm. Dis. Intell. 35 (4):299-300.

Mifsud, C. 2014. Chicken meat. Outlook to 2018-19. Agric. Commod. 4. March Quarter ABARES 101-104. Accessed 28/05/14 at http://www.chicken.org.au/files/ABARES_Chicken_Outlook.pdf.

Ministry of Agriculture and Forestry (MAFF), 2011. Bacterial concentrations of poultry offal and in mechanically separated meat products at the processing plant. MAF technical paper No: 2011/59. May 2011. Accessed 242/05/14 at http://www.foodsafety.govt.nz/elibrary/industry/bacterial-concentrations-of-poultry-offal.pdf.

NEPSS (National Enteric pathogens Surveillance Scheme). Non-human Annual Report 2012.

NEPSS (National Enteric pathogens Surveillance Scheme). Human Annual Report 2010.

OzFoodNet Annual reports, 2009 and 2010 and Quarterly reports for 2011 and 2012 are available at the OzFoodNet reports webpage accessed 20/05/14 at http://www.ozfoodnet.gov.au/internet/ozfoodnet/publishing.nsf/Content/reports-1.

Painter JA, Ayers T, Woodruff R, Blanton E, Perez N, Hoekstra RM, Griffin PM, and Braden C. 2009. Recipes for foodborne outbreaks: a scheme for categorizing and grouping implicated foods. Foodborne Path. Dis. 6:1259-1264.

Rupan, R, Jennison AV, Smith HV, Cobbold RN. 2011. Carriage of Shiga-toxigenic *Escherichia coli* by native marsupials in Australia. Vet. Microbiol. 155:279-283.

Smith, BA, Fazil A, Lammerding AM, 2013. A risk assessment model for *Escherichia coli* O157:H7 in ground beef and beef cuts in Canada: Evaluating the effects of interventions. Fd. Control. 29:364-381.

Squire, M. M., G. P. Carter, K. E. Mackin, A. Chakravorty, T. Noren, B. Elliott, D. Lyras, and T. V. Riley. 2013. Novel molecular type of *Clostridium difficile* in neonatal pigs, Western Australia. Emerg. Infect. Dis. 19:790-792.

USDA, 2013. Interagency risk assessment: *Listeria monocytogenes* in retail delicatessens. September, 2013.(Accessed 28/05/14 at http://www.fda.gov/downloads/Food/FoodScienceResearch/RiskSafetyAssessment/UCM370243.pdf).

Ward, MP, Cowled BD, Galea F, Garner MG, Laffan SW, Marsh I, Negus K, Sarre SD, Woolnough AP. 2013. *Salmonella* infection in a remote, isolated wild pig population. Vet Microbiol. 162:921-929.

WHO (World Health Organization), 2014. Antimicrobial resistance: global report on surveillance. WHO, Geneva.

Appendix 1

Table 14; Proportions of persons consuming meat, poultry and game products and dishes in Australia in 2011–2012 (Data from Australian Health Survey 2011–2012, ABS, 2014)

Major and sub-major meat, poultry and game groups	Age group (years)									
	2-3	**4-8**	**9-13**	**14-18**	**19-30**	**31-50**	**51-70**	**≥ 71**	**≥ 19**	**Total ≥ 2**
Total males ('000) interviewed	292.4	709.7	770.9	660.6	1,977.3	3,112.4	2,365.2	819.2	8,274.2	10,707.8
Total females ('000) interviewed	269.0	662.4	755.1	650.0	1,898.1	3.148.9	2,442.6	992.5	8.482.2	10,707.8
Total persons ('000) interviewed	561.4	1,372.1	1,526.0	1.310.6	3,875.4	6.261,4	4,807.8	1,811.7	16,756.4	21,526.5
MALES	**Proportion of persons (%)**									
Meat, poultry and game products and dishes	63.5	69.0	69.5	70.2	71.7	73.4	74.5	74.8	73.4	72.4
Beef, sheep and pork, unprocessed	13.8	10.8	16.6	21.7	21.0	25.1	28.9	25.2	25.2	23.1
Mammalian game meats	0.0	0.0	0.0	0.1	0.4	0.5	0.1	0.0	0.3	0.2
Poultry and feathered game	11.5	12.2	12.8	17.2	22.4	20.0	17.4	16.4	19.5	18.1
Organ meats and offal, products and dishes	0.0	0.0	0.2	0.0	0.3	0.1	1.1	0.4	0.5	0.4
Sausages, frankfurts and saveloys	8.7	14.7	9.8	7.7	7.6	8.8	7.7	8.2	8.1	8.7
Processed meat	16.5	26.0	25.7	26.4	20.3	25.0	26.4	24.6	24.2	24.4
Mixed dishes where beef, sheep, pork or mammalian game is the major component	9.8	10.3	12.3	12.0	13.6	14.5	13.7	13.8	14.0	13.4
Mixed dishes where sausage, bacon, ham or other processed meat is the major component	0.0	0.0	0.0	1.1	0.2	0.1	0.2	0.1	0.1	0.2

Mixed dishes where poultry or feathered game is the major component	17.0	16.7	17.8	18.5	22.6	14.3	9.6	7.5	14.3	15.0
FEMALES	**Proportion of persons (%)**									
Meat, poultry and game products and dishes	60.3	67.1	71.3	64.0	61.2	67.2	66.1	72.5	66.2	66.3
Beef, sheep and pork, unprocessed	9.4	9.8	14.7	20.1	16.8	20.4	23.9	25.6	21.2	19.7
Mammalian game meats	0.0	0.3	0.0	0.0	0.2	0.1	0.0	0.2	0.1	0.1
Poultry and feathered game	18.8	16.0	23.1	13.8	17.1	19.6	15.2	15.5	17.3	17.4
Organ meats and offal, products and dishes	0.0	0.0	0.0	0.2	0.1	0.3	0.5	1.0	0.4	0.3
Sausages, frankfurts and saveloys	8.7	10.1	7.2	5.4	4.5	5.3	5.1	5.6	5.1	5.7
Processed meat	14.7	23.8	24.9	24.6	19.1	19.0	18.0	22.2	19.1	20.0
Mixed dishes where beef, sheep, pork or mammalian game is the major component	8.6	5.8	11.5	11.2	8.6	10.4	13.1	10.6	10.8	10.5
Mixed dishes where sausage, bacon, ham or other processed meat is the major component	0.0	0.9	0.0	0.0	0.0	0.3	0.1	0.4	0.2	0.2
Mixed dishes where poultry or feathered game is the major component	11.4	19.8	17.8	15.9	15.3	13.7	11.0	7.3	12.5	13.5
TOTAL POPULATION	**Proportion of persons (%)**									
Meat, poultry and game products and dishes	61.9	68.0	70.4	67.1	66.6	70.3	70.2	73.6	69.8	69.3
Beef, sheep and pork, unprocessed	11.7	10.3	15.7	20.9	19.0	22.8	26.4	25.4	23.2	21.4
Mammalian game meats	0.0	0.2	0.0	0.1	0.3	0.3	0.1	0.1	0.2	0.2

Poultry and feathered game	15.0	14.0	17.9	15.5	19.8	19.8	16.3	15.9	18.4	17.8
Organ meats and offal, products and dishes	0.0	0.0	0.1	0.1	0.2	0.2	0.8	0.7	0.4	0.3
Sausages, frankfurts and saveloys	8.7	12.5	8.5	6.6	6.1	7.0	6.4	6.8	6.6	7.2
Processed meat	15.7	24.9	25.3	25.5	19.7	22.0	22.1	23.3	21.6	22.2
Mixed dishes where beef, sheep, pork or mammalian game is the major component	9.2	8.1	11.9	11.6	11.1	12.4	13.4	12.0	12.4	11.9
Mixed dishes where sausage, bacon, ham or other processed meat is the major component	0.0	0.5	0.0	0.6	0.1	0.2	0.2	0.2	0.2	0.2
Mixed dishes where poultry or feathered game is the major component	14.3	18.2	17.8	17.2	19.1	14.0	10.3	7.4	13.4	14.3

Appendix 2

Table 15: Outbreaks reported in OzFoodNet Annual Reports for 2009 and 2010 with assigned or suspected association with meat species. Reports are available at http://www.ozfoodnet.gov.au/internet/ozfoodnet/publishing.nsf/Content/reports-1

Year	State or Territory	Month of outbreak	Setting prepared	Agent responsible	Number affected	Number hospitalised	Number of fatalities	Responsible vehicles (2009) or food vehicle (2010)	Vehicle category (2009) or commodity (2010)
2009	Qld	Oct	Restaurant	Norovirus	23	0	0	Chicken Caesar salad; roast chicken	Chicken and chicken containing dishes
2009	Tas	Sep	Restaurant	*Campylobacter* spp.	35	0	0	chicken liver parfait	Chicken and chicken containing dishes
2009	Tas	Sep	Restaurant	Unknown	9	0	0	chicken liver parfait	Chicken and chicken containing dishes
2009	ACT	Jul	Restaurant	*Y. enterocolitica*	3	0	0	BBQ pork or roast pork	Meat and meat containing dishes
2009	Vic	Feb	Restaurant	Not further specified	10	0	0	Suspected stews and casseroles	Meat and meat containing dishes
2009	ACT	Jul	Aged care facility	*C. perfringens*	52	0	0	Sweet and sour pork probable food vehicle	Meat and meat containing dishes
2009	Vic	Nov	Aged care facility	Not further specified	6	0	0	Unknown	Meat and meat containing dishes
2009	Qld	Aug	Restaurant	*C. perfringens*	4	0	0	Unknown – suspected roast beef, vegetables and gravy	Meat and meat containing dishes

2009	NSW	Nov	Restaurant	*S.* Typhimurium MLVA 3-12-12-13-523	3	0	0	Cooked pork mince and leftover food (mix of tofu, rice, duck)	Mixed dishes
2009	NSW	Apr	Restaurant	Unknown	5	0	0	Suspected lasagne, chicken Caesar salad	Mixed dishes
2009	NSW	Mar	Restaurant	*Campylobacter* spp.	4	0	0	Suspected steak with chips and salad	Mixed dishes
2009	NSW	Jan	Bakery	*S.* Typhimurium PT 170 MLVA 3-9-8-12-523	9	1	0	Suspected cross-contamination with raw mince through piping bag, of chocolate, custard and cream cakes	Suspected chicken and/or eggs
2009	WA	Mar	Restaurant	*S.* Singapore	6	0	0	Unknown – chicken suspected	Suspected chicken and/or eggs
2009	NSW	Mar	Restaurant	*S.* Typhimurium PT 170 MLVA 3-9-7-13-523	2	1	0	Unknown – Fijian chicken suspected	Suspected chicken and/or eggs
2009	NSW	Jan	National franchised fast food	*S.* Typhimurium PT 170 MLVA 3-9-7-13-523	3	1	0	Suspected bacon and beef burgers	Suspected meat and meat containing dishes
2009	NSW	Mar	Bakery	*S.* Typhimurium 170 MLVA 3-9-7-13-523	8	1	0	Suspected chicken/pork rolls	Suspected meat and meat containing dishes
2010	Qld	Jun	Restaurant	*C. perfringens*	4	0	0	Rotti curry lamb	Lamb
2010	NSW	Jan	Takeaway	Unknown	3	0	0	Assorted pizzas (beef, cheese, chicken)	Not assigned

2010	Tas	Feb	Restaurant	Unknown	26	0	0	Chicken mushroom and bacon cream sauce	Not assigned
2010	NSW	Jun	Takeaway	*S.* Typhimurium PT 170/108	45	8	0	Chicken, hommus, tabouli	Not assigned
2010	Vic	Feb	Unknown	*L. monocytogenes*	6	6	4	Cold meat	Not assigned
2010	WA	Mar	Restaurant	Unknown	12	0	0	Karage chicken and rice	Not assigned
2010	WA	Jul	Restaurant	Norovirus	17	0	0	Lasagne	Not assigned
2010	NSW	Feb	Restaurant	Unknown	4	0	0	Possibly lamb, beef & chicken skewers and an assortment of vegetables	Not assigned
2010	NSW	Jan	Restaurant	*S.* Typhimurium PT 9	2	1	0	Probably a pork bun	Not assigned
2010	NSW	Feb	Restaurant	Unknown	3	0	0	Probably chicken or beef	Not assigned
2010	NSW	Nov	Bakery	*S.* Typhimurium	10	0	0	Probably pork roll	Not assigned
2010	SA	Aug	Restaurant	*Campylobacter* spp.	18	2	0	Steak with chicken liver pate	Not assigned
2010	NSW	May	Takeaway	Unknown	2	0	0	Suspect Mongolian lamb or fried rice	Not assigned
2010	NSW	Jun	Restaurant	Unknown	4	0	0	Suspected beef pie	Not assigned
2010	NSW	Jun	Restaurant	Unknown	7	0	0	Suspected chicken in cheese sauce, mixed vegetables	Not assigned

2010	NSW	Dec	Takeaway	*S.* Typhimurium PT 170/108	8	3	0	Suspected pork rolls	Not assigned
2010	NSW	Feb	Takeaway	*S.* Typhimurium PT 204	4	3	0	Barbecued pork	Pork
2010	Vic	Dec	Institution	*Campylobacter* spp.	5	0	0	Chicken	Poultry
2010	NSW	Mar	National franchised fast food	*S.* Typhimurium PT 9	4	1	0	Possibly chicken pieces from franchised restaurant	Poultry
2010	NSW	May	Restaurant	*Campylobacter* spp.	10	0	0	Raw chicken	Poultry
2010	NSW	Apr	Aged care	*S.* Infantis	26	5	2	Suspected fluid thickener contaminated by raw chicken mince	Poultry

Table 16: Outbreaks reported in OzFoodNet quarterly reports for 2011 and to September, 2012 here meat was recorded in the description of the responsible vehicle. Quarterly reports are available at http://www.ozfoodnet.gov.au/internet/ozfoodnet/publishing.nsf/Content/reports-1

Year	State or Territory	Month of outbreak	Setting prepared	Agent responsible	Number affected	Number hospitalised	Responsible vehicles
2011	ACT	Mar	Takeaway	*S*. Typhimurium PT 197	9	1	Chicken kebab, lamb kebab
2011	NSW	Jan	Grocery store/delicatessen	*S*. Singapore	10	0	Roast chicken pieces served cold
2011	NSW	Jan	Grocery store/delicatessen	S. Singapore	46	2	Roast chicken pieces served cold
2011	NSW	Jan	Takeaway	*S*. Typhimurium PT 44	85	17	Vietnamese pork/chicken/salad rolls containing raw egg butter†
2011	NSW	Feb	Restaurant	*Campylobacter* spp.	11	0	Chicken liver pate on toast
2011	Vic	Jan	Takeaway	S. Typhimurium 9	3	1	Chicken sushi (hand rolls)
2011	Vic	Feb	Restaurant	*S*. Typhimurium PT 170	15	6	Salty fish, pork and eggs Vietnamese dish
2011	Vic	Mar	Bakery	*S*. Typhimurium PT 135	18	3	Chicken pate
2011	WA	Jan	Takeaway	*S*. Typhimurium PT 9, PFGE 0001	15	5	Vietnamese pork roll with raw egg butter†
2011	ACT	Jun	Private residence	*S*. Typhimurium PT 135	5	1	Spit roast pig
2011	ACT	Jun	Restaurant	Unknown	6	0	Burgers, schnitzels and chips

2011	NSW	May	Restaurant	*S.* Typhimurium (MLVA profile 3-10-9-8-523)	8	0	Chicken; eggs†
2011	Qld	Jun	Picnic	*Campylobacter* spp.	4	0	Chicken kebabs
2011	Vic	May	Restaurant	Norovirus	26	4	Chicken parmagiana
2011	NSW	Sep	Restaurant	Unknown	6	0	Madras chicken curry with rice
2011	Qld	Jul	Restaurant	*C. perfringens*	3	0	Chicken curry
2011	Qld	Sep	Commercial caterer	*S. aureus*	38	1	Fried rice; chicken; egg fu yung; mussels
2011	Vic	Jul	Restaurant	Unknown	7	0	Beef rendang or pork satay
2011	Vic	Sep	Reception centre	*C. perfringens*	41	0	Roast beef
2011	Vic	Sep	Aged care	*C. perfringens*	14	0	Suspected roast meats
2011	WA	Sep	Commercial caterer	*Campylobacter* spp., S. Typhimurium PFGE type 0007, S. Infantis	65	0	Duck parfait
2011	ACT	Dec	Restaurant	*S.* Typhimurium PT 170 MLVA profile 03-09-07-14-523	41	7	Chicken Caesar roll containing raw egg mayonnaise
2011	NSW	Nov	Commercial caterer	Unknown	16	0	Suspect lamb curry
2011	Vic	Nov	Commercial caterer	*C. perfringens*	17	0	Suspected roast beef
2011	Vic	Dec	Private residence	*S.* subsp I ser 4,5,12:i:- PT 193	4	1	Homemade pork salami
2011	Vic	Dec	Restaurant	Unknown	4	1	Moroccan chicken salad
2011	WA	Nov	Private residence	Unknown	17	0	Chicken biriyani
2012	NSW	Jan	Other	*S.* Muenchen	16	1	Leg of ham

2012	NT	Jan	Restaurant	Norovirus	22	0	Chicken and/or egg sandwiches or cocktails
2012	ACT	Feb	Fair, festival, other temporary/mobile service	*S*. Typhimurium PT 9 / MLVA profile 03-12-16-13-526	10	3	Chicken doner kebab
2012	NSW	Mar	Commercial caterer	Unknown	16	1	Lamb salad
2012	NSW	Mar	Restaurant	*S*. Typhimurium MLVA profile 03-13-09-11-550 (historically PT 135)	4	2	Burger with egg and bacon
2012	ACT	May	Private residence	*Campylobacter* spp.	7	0	Chicken liver pate
2012	WA	May	Restaurant	*Campylobacter* spp.	4	0	Suspected chicken liver
2012	VIC	Jun	Restaurant	*S*. Newport	10	0	Kebabs
2012	Qld	Jul	Restaurant	*C. perfringens*	7	0	Lamb curry
2012	SA	Jul	Restaurant	*Campylobacter* spp.	15	1	Chicken liver pate
2012	Qld	Aug	Restaurant	*S. T*yphimurium PT 16/MLVA profile 03-13-11-11-524	3	3	Chicken Caesar roll containing raw egg dressing
2012	NT	Sep	camp	Shiga toxin-producing *E. coli*	5	1	Kangaroo meat

Responses to questions/matters raised by Dr Patricia Desmarchelier in *Meat Food Safety Scheme: Periodic review of the risk assessment*

The possible emergence of *Clostridium difficile* as foodborne risk

Clostridium difficile has primarily been considered to be risk to hospital patients undergoing antibiotic treatment. The emergence of infections in the community and the isolation of the organism from meat has lead to the suggestion the *C. difficile* is also a foodborne illness.

The Food Authority has been monitoring the emergence of this organism for some time and will continue to do so. At this time there is no obvious specific intervention for *C. difficile* and good hygienic practice in meat processing and in the kitchen, which are already enforced or promoted by the Food Authority, would seem to be applicable.

Organisms with antimicrobial resistance (AMR) in the food supply

Organisms with AMR can cause infections that are difficult to treat or if not a disease risk in their own right they may confer resistance to antibiotics on pathogenic organisms. Food is assumed to vector for transmission of bacteria with AMR.

Control of the spread of AMR has been a national program for many years. The Joint Expert Technical Advisory Committee on Antibiotic Resistance (JETACAR) was established in 1998 (joint because Commonwealth Departs of Health and Agriculture were involved). More recently The Australian AMR Prevention and Containment Steering Group has been developing an AMR strategy. The strategy will guide Australia's efforts across human and animal health, food and agriculture sectors to prevent and contain AMR.

At this stage there is no role for the Food Authority, and it is unlikely that there will be one beyond its existing role in promoting good hygienic practice.

Cooking instructions for mechanically tenderised or moisture infused meats

Tenderising or infusing moisture into meats spread bacteria from the surface of the meats to the centre where they are more likely to survive if meat is under-cooked.

The meat cooking temperatures guide on the Food Authority website should be extended to include cooking times for mechanically tenderised or moisture infused meats.

Through chain interventions to minimise Salmonella contamination of meat

Recently the EU has supported a project to study foodborne pathogens in the beef chain. The conclusion was there was not any 'single intervention-single chain point' combination by which the pathogens would be reliably and entirely eliminated from the chain resulting in total prevention of pathogens in beef and products at the time of consumption. Rather a range of control interventions have to be applied at multiple points along the chain to achieve an acceptable final risk.

The Food Authority is focussed on meat processing, meat transport and meat retailing sectors of the industry and good hygienic practice of the end-user. Neither the current nor the incoming version of Standard 4.2.3 – *Production and Processing Standard for Meat* – provides scope the Food Authority to go on-farm. Meat and Livestock Australia are active in the development producer food safety programs.

Does the Australian poultry meat industry meet carcase microbiological standards being achieved elsewhere in the developed world?

US Food Safety Inspection Service (FSIS) data for 2013 shows that 11,124 Salmonella samples were analysed from young chicken establishments. The total percentage of positive samples was 3.9% in 2013, down from 4.3%, 6.5%, 6.7%, and 7.2% in 2012, 2011, 2010, and 2009, respectively. The results also demonstrate that large plants have better results than small plants which are in-turn better than very small plants. The best of the plants have demonstrated year-on-year improvements and a very low prevalence for 2013.

The Food Authority does not have recent data on *Salmonella* prevalence on poultry carcasses but a cooperative program with industry program has commenced to collect FSIS type data.

Cooking instructions for liver dishes such as pate

Raw or under-cooked liver dishes have caused a number of outbreaks of foodborne illness.

Both FSANZ and the Food Authority have information on their websites about the need for adequate cooking of liver products. The Stakeholder Engagement team could consider if anything else is required.

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