ACM/1166

ADVISORY COMMITTEE ON THE MICROBIOLOGICAL SAFETY OF FOOD

DISCUSSION PAPER

Risk assessment of *Salmonella* from shell eggs

Issue

The purpose of this paper is to seek the Committee's advice on whether the risk to consumers (including vulnerable groups) from consuming lightly cooked or raw shell eggs and their products has changed since the Committee last reviewed the subject of *Salmonella* in eggs in detail between 1998 and 2001. The paper provides background on this issue in light of developments. While hen's eggs are the main focus for consideration, risks associated with other types of shell eggs (e.g. duck eggs) should not be overlooked.

Background

1. Raw shell eggs may become contaminated with *Salmonella* spp. in different ways. The outside of the egg may be contaminated by faeces after laying, or be infected with *Salmonella* spp. during laying if the reproductive tract is colonised by the organism. *Salmonella* spp. on the outside of the egg can migrate through the porous shell to the interior, particularly when newly-laid or under humid conditions. Contamination of the egg contents can also occur from infection of the reproductive tissue prior to egg development (de Buck *et al*. 2004, Humphrey 1994). *Salmonella* bacteria can survive in lightly cooked eggs or raw egg dishes and cause human disease (Humphrey *et al*. 1989, 1990).

2. Foodborne disease outbreaks caused by *Salmonella* have been associated with a variety of foods. However, outbreaks caused by *Salmonella enterica* serovar. Enteritidis (*S*. Enteritidis) tend to be associated with eggs and egg products (Doorduyn *et al*. 2006, Drociuk *et al*. 2003, Gillespie *et al*. 2005, Hayes *et al*. 1999, Mishu *et al*. 1994, Mølbak and Neimann 2002, Schmid *et al*.,1996).

3. In England and Wales, the emergence of *S*. Enteritidis in the late 1980s caused the largest and most persistent epidemic of foodborne infection attributable to a single subtype of any pathogen since the establishment of systematic national microbiological surveillance. It is estimated that >525000 people became ill during the course of the epidemic. The epidemic was associated with the consumption of contaminated chicken meat but more importantly, shell eggs. A decline in numbers of infections started after the introduction of vaccination and other control measures in the production and distribution of eggs and chicken meat (Lane *et. al.,* 2014).

During the epidemic stage, phage type 4 accounted for 159 (79%) of 201 egg-associated *S*. Enteritidis outbreaks (Lane *et al*., 2014). The decline stage was marked by sharp falls in the number and proportion (36/95 or 38%) of egg-associated *S.* Enteritidis outbreaks attributable to phage type 4. Only 5 egg associated outbreaks of phage type 4 infection were reported between 2007–2011. It has been suggested that *S. enterica* serotypes other than Enteritidis are potentially capable of invading the reproductive tract of chickens (ACMSF, 2001) although we have yet to see the emergence of any new egg associated serovars.

4. In March 1991, the Committee set up a sub-group to consider the extent to which eggs were responsible for the incidence of foodborne disease due to *Salmonella.* A Department of Health (DH) funded survey of the prevalence of *Salmonella* contamination of eggs from retail outlets in the high street in 1991 showed that *Salmonella* spp. were isolated from 65 out of 7045 boxes of six eggs (0.92%). A follow-up DH funded survey in 1995/96 demonstrated that the situation had not improved; *Salmonella* spp. were isolated from 138 of 13970 samples of six eggs (0.99%), despite extensive measures adopted by industry to address the problem.

5. Given that there was no obvious explanation for the lack of improvement relating to the prevalence of *Salmonella* contamination of UK eggs between 1991 and 1995/96, the Committee set up a second sub-group in 1998 to establish the factors which determine the presence of *Salmonella* contamination in or on eggs. The Committee looked at *Salmonella* infections in humans and the evidence that eggs have a role in human salmonellosis. It also assessed existing measures to reduce *Salmonella* contamination of eggs, the contribution of vaccination and competitive exclusion, and the storage, handling and use of eggs (ACMSF, 2001).

6. At the time of the Committee's 2001 report, insufficient data were available for the Committee to quantify the risk of *Salmonella* infection from the consumption of raw shell eggs. The Committee did consider a risk assessment model developed by DH with input from members of the working group but concluded that more empirical data were required to support further development of such a model. Since then, more information has become available, particularly on *Salmonella* in laying flocks and prevalence of *Salmonella* contamination in UK and non-UK eggs. The Agency has used some of these data to populate and further develop an exposure assessment model for *Salmonella* and eggs (ACM/937).

A summary of the prevalence of *S.* Enteritidis in chickens and humans

7. Figure 1 below (Lane *et. al*., 2014) illustrates trends in reported incidents of *S.* Enteritidis in chickens in the UK versus laboratory reporting of human *S.* Enteritidis infections between 1985 and 2011. The authors of the paper stated that comparison of trends in reporting data, show that the rise in human *S.* Enteritidis infections matched the rise in disease in chicken farms; layers, breeders and broilers are included in the data (although

since the 2000s, most *S.* Enteritidis incidents in poultry have been associated with layers).

8. Although reporting of incidents in chickens began to decrease in 1994 following introduction of a voluntary national vaccination and flock hygiene programs targeted at breeding flocks, this effect had a limited effect on the trend in reported human infections (Lane *et. al*. 2014). Reports of outbreaks associated with *S.* Enteritidis and chicken did however show a sharp decline from 1994 (Lane *et. al*. 2014). The reporting of egg-associated outbreaks did not start to decline until 1997 however, after the introduction of the *S.* Enteritidis vaccination and flock hygiene program targeted at laying chicken flocks; this point marks a sharp decline in the human *S.* Enteritidis epidemic. Lane *et al*., (2014) concluded that the *S.* Enteritidis epidemic was largely due to eggs because the earlier introduction of *Salmonella* controls in chicken meat production appeared to have a smaller impact on the course of the epidemic than that following the introduction of *Salmonella* controls in layers.

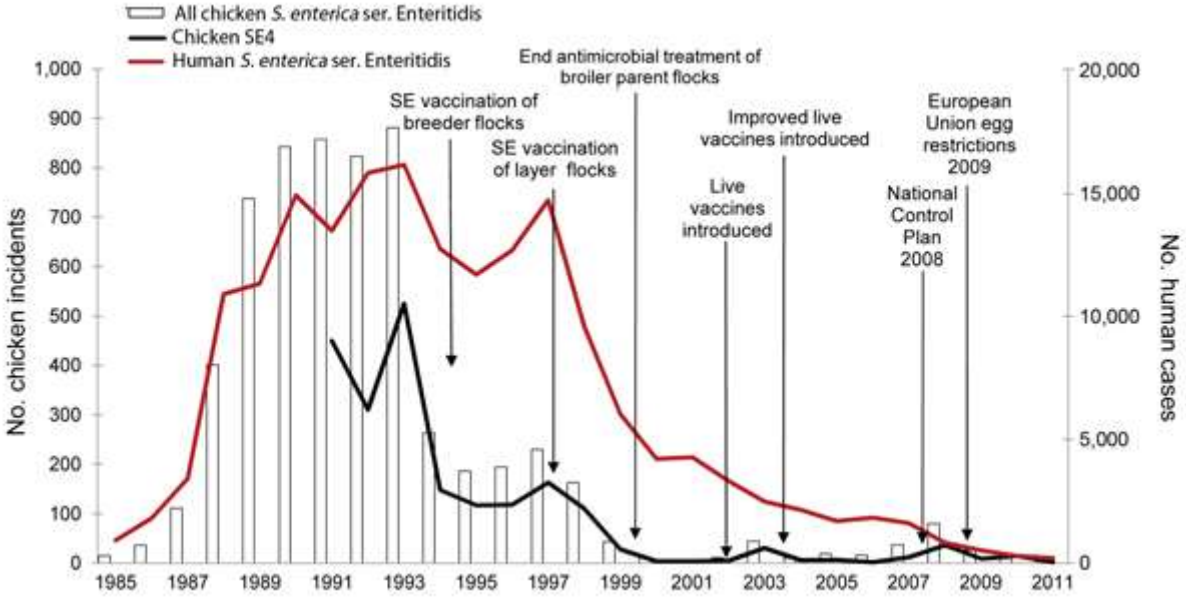

Figure 1 (Lane *et. al.,* 2014): Trends in the reporting of incidents of *Salmonella enterica* serovar Enteritidis in chickens in Great Britain versus laboratory reporting of human *S. enterica* serovar Enteritidis infections, England and Wales, 1985–2011.

9. Since the Committee's 2001 report, additional intervening measures have been implemented nationally and/or EU-wide and are included in the above figure. In 2001, attenuated vaccines were replaced by live vaccines, and in 2003, improved *S.* Gallinarum rough mutant 9R auxotrophic live vaccines were adopted (Lane *et. al.,* 2014). The National Control Plan (NCP) for *Salmonella* in commercial laying hen flocks was implemented in 2008 and set in place the monitoring and controls (biosecurity) required in order to meet the legislative target for reduction in *Salmonella* prevalence

(maximum of 2% of laying hen flocks to remain positive for *S.* Enteritidis and/ or *S.* Typhimurium, including monophasic strains, per year (Regulation (EU) No. 517/2011). Both Government and industry share responsibility for implementation of the NCP (DEFRA, 2010). Additionally, the application of harmonised EU restrictions on the sale of fresh eggs from flocks infected with *S.* Enteritidis or *S.* Typhimurium, began in 2009.

10. There are two data peculiarities in Figure 1 relating to two small increases in reported chicken incidents in 2003 and 2008. The increase in 2003 occurred after early live vaccines were introduced and can be attributed to some farmers being unaware of the level of care needed to deliver the vaccine in the water supply properly; an education campaign was launched to address this (APHA personal communication). The 2007/8 increase can be attributed to additional intensive testing carried out by the egg industry to try and identify any residual infection before egg restrictions were introduced in 2009 (APHA personal communication). In the UK, heat treatment of eggs from positive flocks has only occurred in Northern Ireland and confirmed infected flocks have instead been voluntarily culled, which has helped the UK achieve the lowest *S.* Enteritidis level of any significant poultry producing nation (APHA personal communication).

11. Additionally, data obtained from hen flocks tested under the NCP in the UK between 2008 and 2011 (Figure 2, AHVLA, 2013) illustrate that there has been a decline in the proportion of laying flocks testing positive for regulated serovars (*S.* Enteritidis*, S.* Typhimurium and monophasic variants). The graph shows that the prevalence of regulated *Salmonella* serovars, as well as all *Salmonella* spp. was consistently below the legislative 2% positive target between 2008 and 2013.

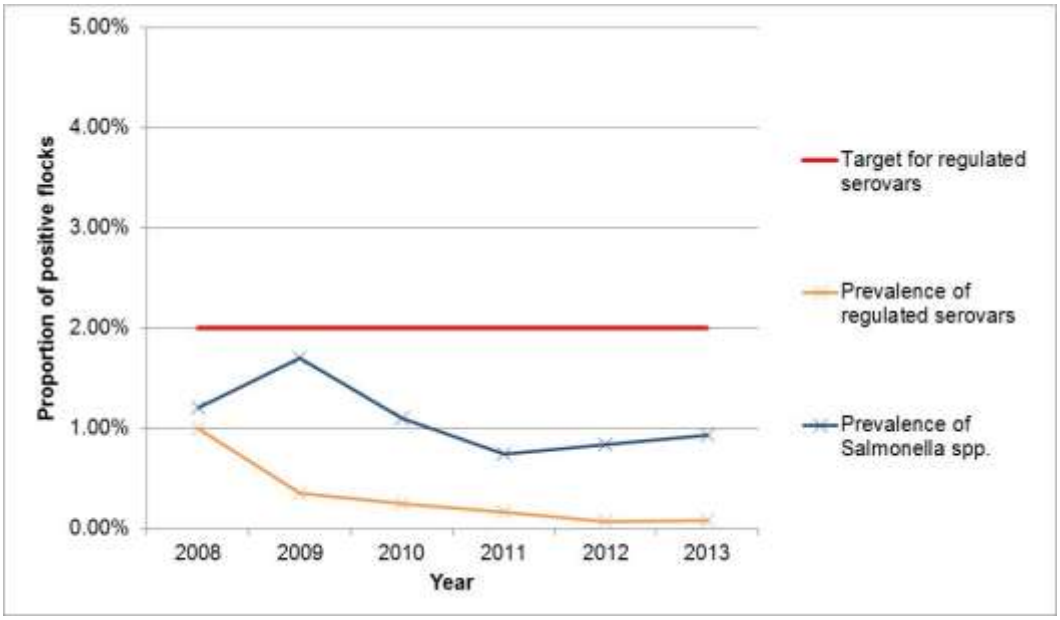

Figure 2: Prevalence of *Salmonella* in laying hen flocks tested under the National Control Program in GB 2008 – 2013 (APHA, 2013).

12. Since the Committee's last report, there has been an ongoing decline in reported human *S.* Enteritidis infections; this can be seen in Figure 1 above. More recently, data from Public Health England showed that *Salmonella* reports have continued to decline in frequency in England and Wales in 2014. The predominant cause of the decline is *Salmonella* Enteritidis which accounted for 33% of non typhoidal *Salmonella* reports in quarters 1-3 of 2014 (compared with 65% for the same period in 2004), and most notably phage type 4 which accounted for 5% of *S.* Enteritidis reported for quarters 1-3 of 2014 (compared with 37% for the same period in 2004.

FSA-funded egg surveys

13. The FSA carried out a survey of *Salmonella* contamination of UK-produced shell eggs on retail sale in response to a recommendation by the Committee in its 2001 report (Food Standards Agency, 2004). The survey was carried out between March and July 2003. A total of 4753 samples (mostly boxes) of six eggs were purchased from a representative cross-section of retail outlets throughout the UK and the shell and contents tested for salmonella contamination.

14. The overall finding was that 9 samples (0.34%) were contaminated with *Salmonella*, which was equivalent to 1 in 290 "boxes" of 6 eggs. All *Salmonella* positive samples were from egg shells only. Comparison with the 1995/96 survey indicated that there had been a threefold reduction in the prevalence of *Salmonella* (from 0.99% to 0.34%). However, the most common *Salmonella* serotype isolated was still *Salmonella* Enteritidis.

15. The Agency carried out a survey of *Salmonella* contamination of raw shell eggs used in catering premises between November 2005 and January 2007. A total of 1,588 pooled samples of six eggs were collected at random from 1,567 catering premises in England, Wales, Scotland and Northern Ireland.

16. The overall finding was that six pooled samples were found to be contaminated with *Salmonella* spp. on the shell of the egg giving a prevalence of 0.38%. Two different serotypes were recovered of which the most common was *S*. Enteritidis (5/6). There were three different phage types (PT) of *S*. Enteritidis with PT4 predominating (3/5). *S*. Mbandaka was also isolated. *Salmonella* spp. were detected from five egg samples that were produced in the UK and from one produced in Germany. The survey's kitchen practice element showed evidence of poor egg storage and handling practices in catering premises (Food Standards Agency, 2007).

Non-UK eggs

17. Several studies have examined *Salmonella* contamination of non-UK eggs. The then Health Protection Agency examined outbreak-associated eggs during 2002 to 2004 and showed a higher rate of *Salmonella*

contamination in or on eggs from outside the UK and used in catering premises. Most *Salmonella* isolates were *S.* Enteritidis non-phage type 4 (5.5% in Spanish eggs; 6.3% in eggs of country of origin not known) (HPA 2004, Little *et al*. 2007).

18. The FSA commissioned a survey of *Salmonella* contamination of non-UK eggs on retail sale in London and the North West of England over a period of 16 months, between March 2005 and July 2006. The estimated prevalence of all *Salmonella* spp. and *S*. Enteritidis was reported to be from 3.3% and 2.6%, respectively.

19. In 2011 and 2014, outbreaks associated with *S*. Enteritidis phage type14b, were reported in the UK and linked to eggs imported from Spain and Germany, respectively.

Duck eggs

20. In July 2010, the then Health Protection Agency reported an exceedance of *S.* Typhimurium DT 8 infections in people in England and Northern Ireland (HPA, 2010b). By the end of October 2010, there were 81 laboratory confirmed human cases from all regions of England and Northern Ireland, an increase of 26% and 41% on the same period in 2009 and 2008, respectively. The descriptive epidemiological investigation found a strong association between infection and consumption of duck eggs. This was the first known outbreak of salmonellosis linked to duck eggs in the UK since 1949 and highlighted the continuing need to remind the public and commercial caterers of the potential high risks of contracting salmonellosis from raw or lightly cooked duck eggs.

Advice to consumers and caterers

21. The Chief Medical Officer and the Agency have previously highlighted the risk associated with eating raw and lightly cooked eggs and issued public health advice on the safe handling and use of eggs. The Agency's advice has always remained that eating raw eggs, eggs with runny yolks or any food that is uncooked or only lightly cooked and contains raw eggs can cause food poisoning, especially in 'at risk' groups such as pregnant women, the elderly and anyone who is unwell. Advice concerning the risk associated with eating raw and lightly cooked eggs was developed when reported human *Salmonella* Enteritidis infections were significantly higher than they are now, although outbreaks linked to eggs continue to occur but less frequently than in the 1990s.

The Committee is invited to:

- Consider and discuss the extent to which the risk to consumers (including vulnerable groups) from eating raw or lightly cooked shell eggs or foods containing them has changed since the Committee last reviewed the subject of *Salmonella* in eggs in detail in 2001. Consideration should also be given to duck eggs.

- Indicate whether it would be appropriate to establish a new sub-group to review the current level of risk from *Salmonella* in eggs.

Secretariat
January 2015

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