ACM/597

ADVISORY COMMITTEE ON THE MICROBIOLOGICAL SAFETY OF FOOD

CAMPYLOBACTER WORKING GROUP DRAFT ADVICE

On-farm control measures against *Campylobacter* spp. in chickens

1. As signalled in ACM/580, the *Campylobacter* Working Group has been working towards submitting a first tranche of advice to the Food Standards Agency in September about the on-farm control of *Campylobacter* in chickens. This advice will be provisional insofar as it may be supplemented at a later date, as necessary, as the Working Group's deliberations continue.

2. The Working Group has agreed the attached **draft** provisional advice,[1] which is now submitted for consideration by Members of the full Committee. Members' agreement is sought to this advice going forward to the FSA as advice of the full ACMSF.

Secretariat
September 2002

[1] NB : the attached document is the final version of the advice which went forward to the Food Standards Agency on 26 September 2002, and reflects suggestions made by ACMSF members at the 19 September 2002 meting.

ON-FARM CONTROL MEASURES AGAINST *CAMPYLOBACTER* SPP. IN CHICKENS

Background

1. A Working Group of the Advisory Committee on the Microbiological Safety of Food (ACMSF) is currently investigating the role of foods in the incidence of human *Campylobacter* infections, and possible control measures. The terms of reference and membership of the Group are at Annex A. The background to the ACMSF's interest in *Campylobacter* is summarised in Annex B.

2. Evidence suggests that human *Campylobacter* infections can be acquired from various sources, both food and non-food. However, the Group believes that poultry, particularly broiler chickens, play a significant role in exposing humans to *Campylobacter.* Whether this is directly related to consumption of chicken (or due to cross-contamination of the kitchen environment and other foods from chicken) is not yet certain.

3. Although the scientific evidence is incomplete, we believe that reducing the incidence of *Campylobacter*-positive retail chicken is likely to be an important step in reducing human infections. We also believe that a declining incidence in poultry would reduce the overall number of *Campylobacter* bacteria in the home and catering environment, thus reducing the number of potential 'infectious doses' faced by the consumer.

4. From the evidence gathered so far, it does appear that reducing *Campylobacter* carriage in chicken production is now becoming a practical proposition, particularly with housed birds, whereas previously many thought it totally impossible.

5. *Campylobacter* control is an important aspect of FSA strategy. In view of the above considerations, the ACMSF has decided that the Working Group's current views on control of *Campylobacter* in chickens should be offered as early advice to the FSA.

6. These views are discussed in the draft 'chapter' which follows.

Introduction

7. Although various food vehicles are possible sources of human *Campylobacter* infection, we judge that particular attention needs to be given to poultry meat.

8. *Campylobacter* spp, principally, *Campylobacter jejuni* and, to a lesser extent, *Campylobacter coli,* are common in commercial poultry flocks. Data from current FSA-, and past MAFF-funded,

research and from the international scientific literature indicate that approximately 60% of housed (broiler) poultry flocks are *Campylobacter*-positive at slaughter age. This will vary from company to company, from farmer to farmer, and between flocks. Where numbers of colonised birds are lower than the average for housed poultry, it is likely that *Campylobacter* will only have become established towards the end of the commercial life of the flock. There appears to be a general trend towards lower colonisation rates in the UK, reflecting the fact that farmers are becoming more successful in preventing the entry of this bacterium.

9. *Campylobacter* control is possible for housed birds, as interventions in Scandinavia have illustrated. There is a much more difficult problem, however, with extensive production systems. A high percentage (>90%) of flocks reared in an extensive system have been shown to be *Campylobacter*-positive at slaughter. A recent study in Denmark found that between 37 and 49% of housed broiler flocks were *Campylobacter*-positive compared to 100% of organic flocks. The interventions we have identified are primarily applicable to housed production.

Sources of *Campylobacter* spp. in poultry

10. Over the last 25 years, since the identification of poultry meat as an important source of human infection with *Campylobacter* spp., there have been many studies in many countries into the epidemiology of this zoonotic pathogen in poultry production. As with many areas of science, there is a degree of dispute over the importance of the various routes of infection, which are shown below: -

    - contaminated water
    - vertical transmission from parent flocks;
    - contaminated feed;
    - carry-over from a previous flock;
    - domestic and/or wild animals;
    - contaminated transport crates, vehicles and personnel at flock thinning;
    - feed withdrawal; and
    - the external environment around the broiler house.

11. Although the epidemiology of *Campylobacter* infection in chickens has some similarities to that of *Salmonella* spp., there is one important difference. *Salmonella* primarily enters poultry flocks

when the chicks are very young. *Campylobacter* is rarely found in broiler flocks until the birds are in the third week of life. There is currently no agreement on the reason(s) for this delay but the following have been suggested as having a role: -

- maternal antibodies in young chicks, as most broiler-breeder flocks are *Campylobacter*-positive and anti-*Campylobacter* antibodies may be present in egg yolks;

- the presence in young birds of bacterial floras antagonistic to *Campylobacter* spp.

12. The control of *Campylobacter* spp. in poultry production is essentially one of identifying ways by which the three-week *Campylobacter*-free period can be extended until slaughter age.

Contaminated water

13. One study, on a farm in the UK in 1993, and a number of investigations in Scandinavia, have demonstrated that contaminated water, particularly when untreated ground water is used, can be responsible for the introduction of *Campylobacter* spp. into poultry flocks. The 1993 study also raised the intriguing prospect that viable but non-culturable *Campylobacter* (VBNC) were responsible for the initial colonisation event. There is much dispute about the importance of this physiological state. Of all the potential routes, waterborne infection should be the easiest for producers to control. It is very important that all poultry flocks receive only water of potable quality. Additional treatment, in the form of chlorine dioxide or ozone, is also likely to prove beneficial. This approach was part of a package of measures shown to markedly reduce flock colonisation in an on-farm trial in the East of England.

14. Drinking water provided by bell drinkers may also act as a vehicle for horizontal transmission within the broiler house once *Campylobacter* has become established.

Vertical transmission from parent flocks

15. Investigations in the USA provide some evidence to support the view that certain strains of *C. jejuni* may be transmitted vertically from colonised breeder flocks. However, this is a highly contentious area, and it has yet to be demonstrated beyond reasonable doubt that *Campylobacte*r spp. can be isolated from newly hatched chicks. It may be that the bacteria track up from the cloaca and become transient colonisers of reproductive tissues. The fact that it is very difficult to isolate *Campylobacter* from birds less than 2-4 weeks of age is also an argument against vertical transmission, although it cannot yet be ruled out as an occasional route. In addition, the fact that some farms continuously produce *Campylobacter*-free flocks

also makes vertical transmission less probable. There is a possibility that a small number of chicks are *Campylobacter*-positive at hatching, and that the bacteria take time to spread through the flock to a sufficient level to allow detection.

Contaminated feed

16. It is well established that contaminated feed is a potentially important route of flock infection with *Salmonella* spp. This does not seem to be the case with *Campylobacter*. The ubiquity of *Campylobacter* in food animals and the environment means that raw feed ingredients will often be contaminated with these bacteria. However, *Campylobacter* are very sensitive to dry conditions and have been shown to die quickly when present in poultry feed. Although the *Salmonella* control measures in place in the UK to improve feed hygiene will be adequate to control *Campylobacter* spp., it is important to remember that, as with water, feed can act as a vehicle for horizontal transmission in a broiler house once *Campylobacter* has become established.

Carry-over from a previous flock

17. Some studies have demonstrated that the same type of *Campylobacter* can be isolated from successive flocks. One possible explanation is therefore that the bacteria were carried over from one flock to the next. It is also possible that both flocks were colonised from the same source. However, laboratory-derived data indicate that *Campylobacter* are significantly more sensitive to damaging conditions than *Salmonella*. Thus, if house cleaning and disinfection are undertaken properly, then *Campylobacter* will be absent from cleaned houses, and any regime, which removes *Salmonella* spp., will eliminate *Campylobacter.* It is thus unlikely that this potential source is important, although one study in Denmark found that the majority of broiler flocks (11/12) carried identical *Campylobacter* isolates in two or more flocks. As discussed above, it was not possible, in this study, to differentiate between carry-over and a common source. Whatever the importance of carry-over, given the ability of *Campylobacter* spp. to colonise, it is essential that house cleaning and disinfection is rigorously carried out.

Domestic and/or wild animals

18. Most warm-blooded animals carry *Campylobacter* spp. Wild animals act largely as an indirect source of flock infection, as a consequence of environmental contamination. Similarly, farms with mixed animal species also run the risk of increased flock infection because farm staff may transmit the bacteria from cattle, sheep or pigs to chickens. The increased risk that this poses may seriously undermine biosecurity, and a potentially important control measure

is to rear chickens on species mono-specific farms. Given that cats and dogs are also frequently *Campylobacter*-positive, it is also important that these animals are not allowed access to poultry flocks. Anti-*Salmonella* control measures, which prevent the access of wild birds and rodents, will contribute to protecting flocks from *Campylobacter* colonisation too.

Contaminated transport crates, vehicles and personnel at flock thinning

19. Many poultry companies in the UK carry out the practice of "thinning". Broiler houses are stocked with numbers of birds which would be above the welfare recommendation for stocking density if all the birds remained until slaughter weight. To overcome this, at approximately 4 weeks of age, a cohort of birds is removed for slaughter, with the remainder being kept for 2-3 weeks further. This practice has a number of important public health implications, in relation to contamination introduced on-farm by staff and visitors and on crates, as well as the deleterious effects of stress caused by thinning.

20. During the thinning process, crates that may be contaminated can introduce *Campylobacter* into a previously negative flock. The gloves and clothing of the catchers have also been shown to be *Campylobacter*-positive. The potential ingress of *Campylobacter* is compounded by the fact that the birds often become stressed as a result of the catching process. This may render those remaining in the house more susceptible to colonisation with *Campylobacter* spp.

21. Birds are transported to slaughter in crates by lorry. During catching, loading and transportation to the processing plant, the crate surfaces and the lorry decks become contaminated with faeces from the birds in the crates. The cost of poultry transport crates means that they are used repeatedly. Given the high incidence of *Campylobacter* in broiler chickens, crates are frequently contaminated with these bacteria. Crates must be cleaned and disinfected after use. They are washed at the processing plant, but this process has been shown to be far from ideal. The water is often re-cycled from the processing plant, is often used at ambient temperature, and the levels of detergents and/or disinfectants are often sub-optimal and may also be quickly neutralised by the high levels of organic matter present in the crate wash water, which will be re-cycled within the crate washer. Crates therefore often leave the washer contaminated with *Campylobacter* spp.

22. Schedule 1 of The Welfare of Animals (Transport) Order 1997, states that means of transport and receptacles shall be constructed, maintained and operated so as to allow appropriate cleaning and disinfection. The Transport of Animals (Cleansing and Disinfection) (England) (No. 2) Order 2000 requires all animal transport vehicles

and containers to be cleansed and disinfected after each use and within 24 hours of the journey being completed. The Assured Chicken Production Scheme (ACP) has produced a leaflet entitled **"**Poultry standards: catching, transport and slaughter"**.** Rule 3.7 states that *"Processing plants must provide cleaning and sanitation provisions for crates and transporters. All transporters and crates must be washed after unloading*". No information is given about perceived best practice.

23. The decks of vehicles used to carry the crates also become contaminated and will spread contamination if they are not adequately cleansed and disinfected between journeys. In addition, as lorry tyres are potential vectors of *Campylobacter*, there should be a disinfectant wheel bath, or each wheel should be sprayed before entry to, and exit from, a poultry unit.

24. In an ideal world, the practice of thinning should be discontinued, to reduce the risks of transmitting *Campylobacter* infection. However, we have received very strong submissions from informed industry sources underlining the difficulties the industry is facing in what is a highly competitive and price-sensitive sector where import penetration is a continuing threat. We believe that, in terms of microbiological safety, if thinning is practised, it is essential that crate and lorry washing is properly carried out and that crates are not contaminated with *Campylobacter* (or, indeed, other pathogenic microorganisms). Other biosecurity measures are also essential, in relation to clothing, footwear, etc. We believe that improved hygiene standards will yield improved benefits in flock health and may help offset the increased costs involved (see paragraph 50).

<u>The effects of feed withdrawa</u>l

25. An important hygiene problem in broiler processing is the accidental contamination of the carcass at slaughter by gut contents, particularly faecal material, and, as a consequence, the spread of pathogens such as *Campylobacter*. To reduce the danger, food is withdrawn some time before birds are loaded into their transport crates, whether at thinning or at final depopulation. Fasting periods of 4-10 hours have been recommended, (indeed, in our Report on Poultry Meat, we concluded that, on balance, a period of between 6 and 10 hours should be allowed between feeding and kill). However, the overall period without food will be longer than this because of the time taken to load and transport the birds to the processing plant, and any time spent waiting in lairage before slaughter. These factors must be taken into account by the farmer when deciding when to withdraw feed. The average transport time for broilers in the UK is 3.6 hours, although some birds can spend over 12 hours in crates before slaughter. It is possible that broilers could spend between 7-20 hours without food before slaughter.

26. There is continuing debate about whether these fasting times are, in fact, beneficial. Reducing the gut contents will reduce the pressure on the intestines and any leakage of contents on to the carcass if the gut is accidentally broken during evisceration. However, even prolonged food withdrawal will not completely prevent defaecation occurring during *ante mortem* handling. Removing food, or both food and water, have similar effects on gut contents. Most reduction in weight occurs in the crop, and least in the caeca and cloaca. An important finding is that the contents of most parts of the gut, but particularly those of the crop and cloaca, get wetter with longer deprivation. In contrast, caecal contents become slightly drier. Fasting tends to progressively increase the number of Enterobacteriaceae and *Campylobacter* in all parts of the gut but especially in the caeca and cloaca.

27. Food withdrawal will not eliminate cross-contamination of the plumage of live birds with faecal matter during transport. Moreover, it may also have unforeseen adverse effects by inducing stress, which may pre-dispose birds to *Campylobacter* infection. Work with *Salmonella* spp. has shown that birds may become systemically infected very rapidly (within 2 hours) after exposure to sources of infection. It is likely, given the commonness of *Campylobacter* in poultry, that infection with this bacterium will be equally rapid. Food withdrawal may also affect the microbiological flora of the gut by modifying the growth of bacteria normally present, such as lactobacilli, with subsequent changes in the pH of the gut contents. Lactobacilli are also known to have the ability to prevent/reduce intestinal colonisation with zoonotic pathogens. For example, a study, which examined the effects of stress in young monkeys, found that this was associated with a reduction in levels of lactic acid bacteria in the gut. Many of the stressed animals became infected with *C. jejuni*, which was endemic in the colony. It is also of interest that longer feed withdrawal times (up to 24 hours) are associated with a higher prevalence of chickens testing positive for *C. jejuni* in cloacal swabs before slaughter, and caecal swabs after. Thus, do the possible increased risks of gut breakage, and greater susceptibility to infection, outweigh perceived benefits on lower carcass contamination levels with zoonotic pathogens like *Campylobacter* spp ?

28. Whatever the pros and cons of the above, it would not be unreasonable to postulate that birds remaining after thinning might be more susceptible to infection as a result of a combination of disturbance and feed withdrawal.

<u>The environment as a source of flock colonisation</u>

29. Although flock colonisation is possible by any of the routes identified above, there is a general agreement in the international scientific community that the environment around the broiler house is the

most important source of flock colonisation. *Campylobacter* spp. can be isolated with regularity from the farm and the natural environment. It has been shown that *Campylobacter* spp. from the external environment can match those in broiler chickens. The bacteria are present in the environment as a consequence of faecal contamination from wild and domestic animals. A recent study in Denmark has cast some doubt, however, on the role of wild animals as sources of *Campylobacter* spp. for broiler chickens, but did confirm the importance of the contaminated environment. The use of manures as fertilisers also constitutes an infection risk. Investigations with one UK poultry producer, whose system is typical of UK production, demonstrated that farmers with poor farm hygiene practices were more likely to produce *Campylobacter*-positive flocks than those whose hygiene was good. The inference to be drawn from this work is that "dirty" farms are likely to have a higher loading of *Campylobacter* in the environment, and that "dirty" farmers may be more likely to carry the bacteria into the broiler house.

30. A number of different *Campylobacter* sub-types can be isolated from a broiler flock, and even from the same bird. In general, however, one or two sub-types will dominate the bacterial population. There is some dispute over whether the different subtypes indicate the entry of two different bacteria, or whether the genomic instability of *Campylobacter* leads to changes in the original strain, which produce an identifiably different bacterium. The principal event in the colonisation of a broiler flock is the establishment of the bacterium in the first bird(s). Passage through a chicken has been shown to greatly increase the ability of *Campylobacter* to colonise subsequent birds. Spread can be very rapid in a newly colonised flock, and almost all birds will be *Campylobacter*-positive within a few days of the initial colonisation event. A major component of any control strategy must therefore be to prevent *Campylobacter* from the environment entering the broiler house.

31. The most important anti-*Campylobacter* control measures, falling within the term "biosecurity", help ensure that the bacterium is kept out of the broiler house. It is important to note that *Campylobacter* is more difficult to exclude from chickens than *Salmonella* spp. Thus, measures which exclude *Salmonella*, may not be successful with *Campylobacter*. With this bacterium, the margins for error are much smaller, and much more attention to detail may be required in order to achieve robust security. Good farming practice and high levels of stockmanship are seen as an essential basis for the successful and continuing avoidance of *Campylobacter* entry and spread.

32. The average broiler flock experiences many visits by different people during the growing cycle. Each one carries with it the risk of

allowing *Campylobacter* into the flock. Visits should be limited to essential personnel, with each visit fully justified and recorded. There will still be at least daily visits to the flock by farm staff, and it is vital that these are undertaken as hygienically as possible. One study in SW England found that, when farm staff dipped their footwear in strong phenolic disinfectant, it was possible to either prevent or delay flock colonisation in three flocks. This method may be difficult to sustain for long periods, as the disinfectant baths may not be changed with sufficient regularity and can become contaminated with soil and other organic matter. A much better approach is to supplement the foot dips by constructing a hygiene barrier at the entrance to the anteroom, which adjoins the area housing the birds. Wider, more easily cleaned, concreted areas separating the entrance to the houses from the farm environment would also increase the buffer zone. Sets of dedicated outer clothing and footwear should be held on the inside of the hygiene barrier. All people who enter the broiler house should remove their own footwear and put on the protective clothing and shoes/boots. Footwear should also be dipped in disinfectant baths before entry into the flock.

33. The above approach has been shown to be effective in trials in the UK and over a sustained period in the Netherlands and Scandinavia, and we see no reason why this type of *Campylobacter* control requirements cannot be incorporated into farm assurance schemes in the UK. Moreover, these measures have the advantage of being relatively inexpensive. All companies should have standard operating procedures for biosecurity and related matters. There should be a forward looking veterinary health plan which includes appropriate training of all farm staff on how to prevent the introduction of infection into flocks. Farmers also need to be convinced that no emergency, flood and fire apart, is so urgent that the broiler flocks can be entered without outer clothing and footwear being changed. Precautions must encompass all visits to the site, both human and vehicular. A single visit can result in flock colonisation by *Campylobacter* spp.

34. We are confident that properly applied biosecurity will significantly reduce the incidence of *Campylobacter* colonisation in housed chickens.

Broiler flock health and *Campylobacter* colonisation

35. It is perhaps natural, given its commonality in poultry, to regard *Campylobacter* as normal gut flora in chickens. Given that it is now possible for many producers in the UK, and elsewhere in Europe, to regularly produce *Campylobacter*-negative chickens, this definition may need to be reviewed. *Campylobacter* in housed chickens does not seem to behave like either, eg., *Escherichia coli* or faecal streptococci which will be found in all chickens, irrespective of their

Campylobacter status. A more accurate description for *Campylobacter* in housed flocks would perhaps be “frequent coloniser”. There have been many studies on risk factors for broiler flock colonisation with *Campylobacter.* One currently in progress in the UK includes an examination of the relationship between flock health and performance, and the presence of *Campylobacter*. An examination of data from poultry companies shows that farmers differ markedly in their ability to produce chickens which, at slaughter age, are *Campylobacter*-free. Some farmers can rear negative flocks with high frequency, whilst, with others, almost all birds will be *Campylobacter*-positive. These observations give reasons for confidence that practical measures are available for reducing *Campylobacter* on a commercial basis.

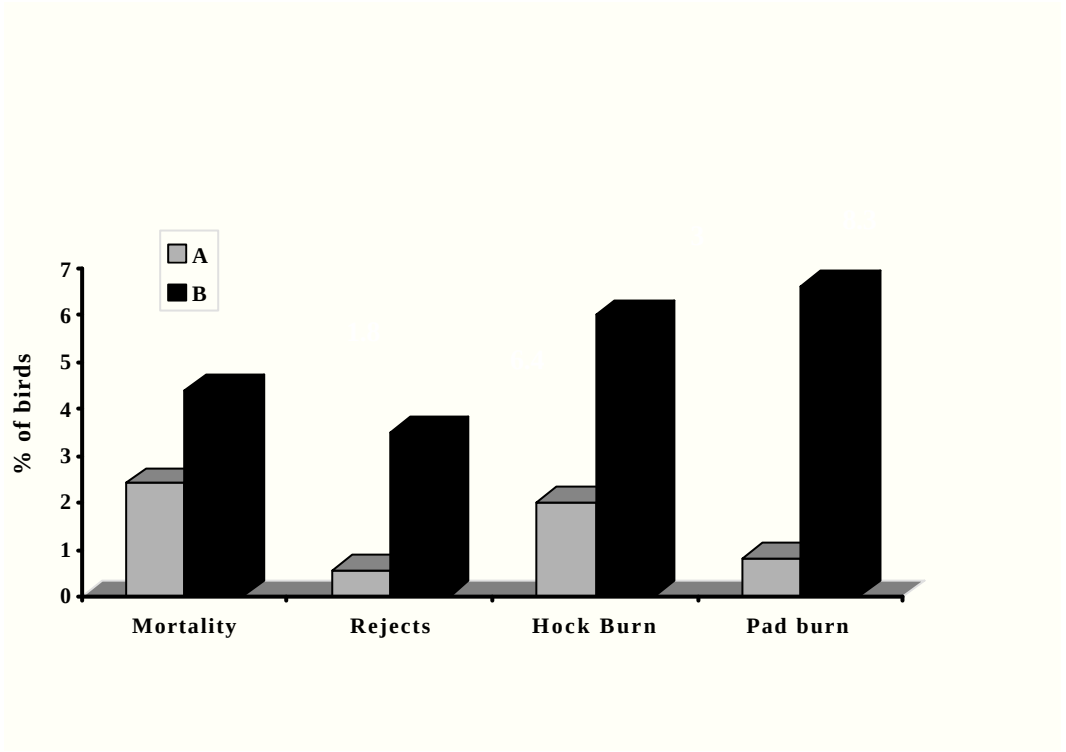
36. Data presented in Figure 1 compare two farmers. One (A) had only 1.4% *Campylobacter*-positive chickens over six flock cycles. In contrast, 97% of birds from the other farm (B) were colonised over the same period. The feed was identical and both farms received the same type of birds, albeit possibly from different broiler-breeder flocks and from breeders of different ages. This latter point may be of importance, as industry data suggest that chicks from breeder flocks that are either entering or leaving the period of lay will be of potentially poorer quality than when breeders are in the peak period of productivity. The comparison below shows that there are marked differences between the two flocks in terms of flock mortality, the level of rejects at slaughter, and in two measures of the nature of the material upon which the birds sit, namely hock and pad burn. In each case, the birds from the farm, which almost always produces *Campylobacter*-negative birds, had better production scores. One interpretation of these data is that birds in which health, performance or welfare are poor are compromised in their ability to withstand challenge from *Campylobacter.*

37. One factor that might differ between the two farms is dryness of the litter, and this known to be an important factor in the epidemiology of *Salmonella* infection. Data from Sweden suggest that *Campylobacter* spp. in dry litter may be less infectious than bacteria in wet litter. This was addressed in a recent study in Sweden, which saw a reduction in flock infection with *Campylobacter* spp. following the introduction of nipple drinkers, which led to an increase in litter dryness. Further improvements were seen when Swedish farmers started to use scoring of foot pads as a parameter for adjusting the density of birds in a shed.

38. The aetiology of hock and pad burn is not yet fully understood but essentially they are manifestations of physical damage to the birds’ feet and legs as a consequence of contact with litter of poor quality. The cause of these lesions is multi-factorial, and industry sources suggest that they come about as a combination of poor diet, poor ventilation and over-supply of drinking water leading to wet litter.

Evidence currently available indicates that there is little relationship between the incidences of the two lesions. These problems are not confined to housed birds and are seen with free-range birds also.

Figure 1: A comparison of low and high *Campylobacter* farms in relation to certain health/quality indicators



Farm A has consistently fewer *Campylobacter*-positive chickens.

Farm B has consistently greater numbers of *Campylobacter*-positive chickens.

NB : The vertical axis uses an arbitrary scale to compare birds from the two farms. In essence, the data on mortality and rejects at the processing plant are recorded figures whereas those for hock and pad burn are the recorded figures divided by 10. This was done to allow an easier comparison between farms.

Source : Unpublished data from the University of Bristol

39. There are welfare and public health needs to identify the key differences between "good" and "bad" farmers with respect to *Campylobacter* status. If it is true that healthier chickens are better able to resist *Campylobacter*, then there are two potential benefits for the poultry industry. Productivity and profitability will be improved, and contamination levels with *Campylobacter* will be reduced.

Vaccinations and other treatments as anti-*Campylobacter* measures

40. Surveillance of *Campylobacter* isolates from human cases and chickens has shown that strains present in the latter are not always found in the former. This raises the intriguing prospect that some chicken-associated *Campylobacter* strains are non-pathogenic for humans. Given that the poultry gut flora usually contains a dominant *Campylobacter* type, the non-pathogenic strains may have a role as agents to exclude potential human pathogens. Recently published work has shown that, under laboratory conditions, birds colonised with one *Campylobacter* isolate were able to resist challenge with another. Caution may be needed with this approach. The genome of *C*. *jejuni* contains many repeat sequences and these allow a high degree of genetic adaptability. Given that passage through the chicken gut increases the ability of *C. jejuni* to colonise other chickens, it must be established beyond all reasonable doubt that the strains used as exclusion agents do not change to become human pathogens.

41. The use of mixed bacterial cultures as an anti-*Salmonella* measure in broiler production is well established in the international poultry industry, and this approach is usually referred to as 'competitive exclusion'. Some work has been undertaken to try to develop preparations with efficacy against *Campylobacter* spp. Results have been mixed so far. Another approach may be possible. Young, *Campylobacter*-negative, broiler chickens have been shown to have a gut flora, which is naturally antagonistic to *C. jejuni*). Experimental data indicate that these gut bacteria, under laboratory conditions, are able to protect against challenge with broth cultures of *C. jejuni*. This may provide an explanation for why chickens do not usually become *Campylobacter*-positive until the third week of life. More work is needed on this approach, but it has the advantage of being a 'natural' phenomenon.

42. In common with all other bacteria, *Campylobacter* spp. can be attacked by viruses, which are known as phages. These viruses generally have a limited host range, a fact, which allows them to be, used as typing agents for both *Campylobacter* and *Salmonella* spp. Phages are found naturally in the chicken gut and offer another potential control measure. Research on this approach continues but it may one day be possible to treat a *Campylobacter*-positive flock a few days before slaughter to either reduce or eliminate carriage of the bacteria. A possible danger with this approach is that it might lead to an increase in the prevalence of phage-resistant *Campylobacter* strains.

43. The genome of a strain of *C. jejuni* has been sequenced, which has made it possible to better understand the behaviour of this bacterium. Work is in progress to establish a library of

Campylobacter strains with mutations in different single genes. By using these bacteria in chicken colonisation studies, it should be possible to identify the genes, which enable *Campylobacter* to establish in the chicken intestine. A medium to long term aim of this work is that, by better understanding the genetics of gut colonisation, it may be possible to produce component vaccines against particular cell targets.

44. Another long-term anti-*Campylobacter* measure is to develop breeds of chickens, which cannot be colonised with these bacteria. It has already been established that genetic lines of chickens differ in susceptibility to *Salmonella* spp., and work is in progress to examine whether similar differences will be seen with *Campylobacter* spp.

Conclusions

45. It is becoming clear that control of *Campylobacter* on-farm is now a practical proposition, at least with birds that are housed. The first commitment must be to rigorous biosecurity, combined with high standards of stockmanship and attention to good flock health and stress control. This will involve such measures as restricting farm visits to essential personnel; ensuring visits are undertaken as hygienically as possible; and appropriate staff training on flock infection. The control of *Campylobacter* on-farm presents a greater challenge than that associated with the control of *Salmonella*.

46. In addition, it is clear that a well-run broiler farm can reduce the incidence of *Campylobacter* through adherence to a number of key principles. It should:-

- be species mono-specific (i.e. farm only chickens);
- supply the birds with water of potable quality;
- properly clean and disinfect houses after flock removal, which should include disinfection of the water supply system;
- protect the house from entry by wild birds and rodents;
- supply feed, which has received treatment sufficient to have eradicated *Salmonella,* (and, hence, *Campylobacter*) and protect it from re-contamination;
- only carry out thinning if done in association with proper crate washing (so that crates are not contaminated with *Campylobacter* spp. or other pathogenic microorganisms) and proper biosecurity measures covering eg., clothing and footwear;

- ensure that transport crates and vehicles are cleaned and disinfected properly on every occasion; and

- maintain general biosecurity and hygiene barriers at a high level, to prevent infection from the farm environment.

47. In our view, the reduction of *Campylobacter* would be greatly assisted if the practice of thinning were to be discontinued. However, as we have noted, there are important economic reasons why the industry wishes to persist with this practice.

48. In risk assessment terms, a lower incidence of *Campylobacter* in broiler flocks is also likely to be reflected in lower numbers of organism in individual birds in the flock, and on finished carcasses. An important factor in consumer exposure to *Campylobacter* is the frequency and level of contamination of the chicken brought into the home or into catering kitchens.

49. We accept the advice we have received from various parts of the poultry industry that broiler chicken production is extremely price competitive and that the UK industry is faced with continuing threats of import penetration.

50. We do recognise that many of the measures for controlling *Campylobacter* in chicken imply additional production costs. However, there is increasing evidence that there are direct links between the general health status of birds and their susceptibility to *Campylobacter* infection. In addition, the maintenance of good flock health conveys economic benefits. Measures put in place for the control of *Campylobacter* might also help reduce the risk of introducing other infections into the flock.

51. We assume that the Food Standards Agency will continue to use routine surveillance of retail chicken for *Campylobacter* to assess the effectiveness of *Campylobacter* reduction programmes. The potential value of industry data as an output measure should not be overlooked even if, for reasons of commercial sensitivity, such information cannot be made publicly-available outside the FSA.

Recommendations

52. We recommend that the Food Standards Agency utilises the conclusions we have drawn to intensify its work with the poultry industry and other stakeholders to achieve wider acceptance that *Campylobacter* control of housed birds is now possible. A primary aim should be to develop an industry-wide programme to spread the "good farming" practices and biosecurity measures which lie at the heart of the matter.

53. In an ideal world, the practice of thinning would be discontinued. However, we recognise that the economic pressures on the industry make this impossible at the present time. We therefore recommend that the Food Standards Agency, in collaboration with the Department for Environment, Food and Rural Affairs, as appropriate, should explore with the industry the conditions which might allow the ending of the practice of thinning in the longer-term. Alternatively, the possibility should be examined of modifying thinning procedures so as to reduce the threat to the biosecurity of broiler houses.

54. Given that thinning will continue, then the hygiene conditions involved, such as crate washing and other biosecurity measures (including clothing and footwear), would need urgent improvement. Again, this is a matter to be taken up with stakeholders.

55. We recommend that the Food Standards Agency acts to achieve a high degree of cohesion between the various research groups involved with *Campylobacter*, so that effort is not duplicated, and to ensure that research is focussed on the most appropriate aspects of the problem.

56. Indications of some of the more important research topics are shown in Annex C.

(cm7049)

ANNEX A

ACMSF *CAMPYLOBACTER* WORKING GROUP

Terms of reference

To identify any important gaps and omissions in action taken to reduce *Campylobacter* in food and food sources and in the knowledge base; and to develop advice which will assist the Food Standards Agency in evolving its strategy for reducing the incidence of foodborne *Campylobacter* infection in humans.

Membership

Chairman Professor D L Georgala	Independent scientific consultant. Retired Director of the Institute of Food Research.
Members	
Mr M Attenborough	Technical Director, Meat and Livestock Commission.
Dr E Berndtson	Svenska Klackeribolaget AB, Sweden. *Campylobacter* consultant to the Swedish Poultry Association.
Ms S Davies	Principal Policy Adviser, Consumers' Association
Professor M J Gasson	Head of Food Safety Science Division, Institute of Food Research
Professor T J Humphrey	Professor of Food Safety, University of Bristol
Professor P R Hunter	Professor of Health Protection, University of East Anglia
Professor A M Johnston	Professor of Veterinary Public Health, Royal Veterinary College, University

	of London
Mr A Kyriakides	Head of Product Safety, Sainsbury's Supermarkets Ltd
Ms E Lewis	Computer consultant. Consumer representative
Dr S J O'Brien	Head of Gastrointestinal Diseases Division, Public Health Laboratory Service Communicable Disease Surveillance Centre
Mr B J Peirce	Hotel owner. Caterer

ANNEX B

ACMSF involvement with *Campylobacter*

- Interim report in 1993 by ACMSF identifies poultry as an important cause of human campylobacteriosis, makes various research recommendations, and also advises the food industry on necessary hygiene measures and HACCP.

- In 2000 the Committee decides to revisit the problem, and to establish a Working Group specifically to do this, reflecting the fact that *Campylobacter* has become far and away the biggest cause of foodborne bacterial infectious intestinal disease in the UK.

- Primary aim is to develop advice which will assist FSA in evolving its strategy for reducing the incidence of foodborne *Campylobacter* infection in humans.

- Working Group set up with members drawn from veterinary, epidemiological, public health, and microbiological sciences, and also with two lay members and industry technologists (including one from Sweden).

- With FSA support, ACMSF holds workshop in February 2002 of invited outside specialists and industry experts.

- Working Group concentrates early attention on the role of poultry, and receives input from a variety of sources, and prepares early advice for FSA.

- A second focus concerns disputes about preferred laboratory methodology, which emerged strongly at the workshop mentioned above.

- Plans for the near future include sending some of the Working Group to visit Norway and Denmark, where progress is reported in reducing *Campylobacter* in poultry. Information from this visit will supplement input from the Swedish member of the Working Group.

ANNEX C

POSSIBLE RESEARCH AREAS (see paragraph 56)

We would support research funding in the following areas:-

- a detailed examination of the relationship between broiler flock health and husbandry, and *Campylobacter* colonisation. This should include an examination of litter quality and feed composition;

- an examination to determine whether vaccines received by broiler chickens in the second and third weeks of life compromise the ability of the chickens to exclude *Campylobacter* spp;

- the impact of feed withdrawal on *Campylobacter* levels in chicken intestines and on carcasses;

- the impact of thinning, using crates with or without *Campylobacter* spp. as contaminants, on flock colonisation levels;

- the effect of thinning on stress levels in the birds remaining in the poultry house, and their subsequent behaviour and susceptibility to infection with *Campylobacter* spp;

- the use of naturally-occurring and introduced competitive bacteria as agents to prevent flock infection with *Campylobacter* spp;

- the use of phage, to prevent flock infection or to remove a pre-existing infection before slaughter;

determination of which aspects of enhanced biosecurity (and these include hygiene barriers, water treatment and visitor reduction) are the most important in preventing flock infection with *Campylobacter* spp.