

MICROBIOLOGICAL FOODBORNE DISEASE STRATEGY

July 2001: Revised post Board discussion

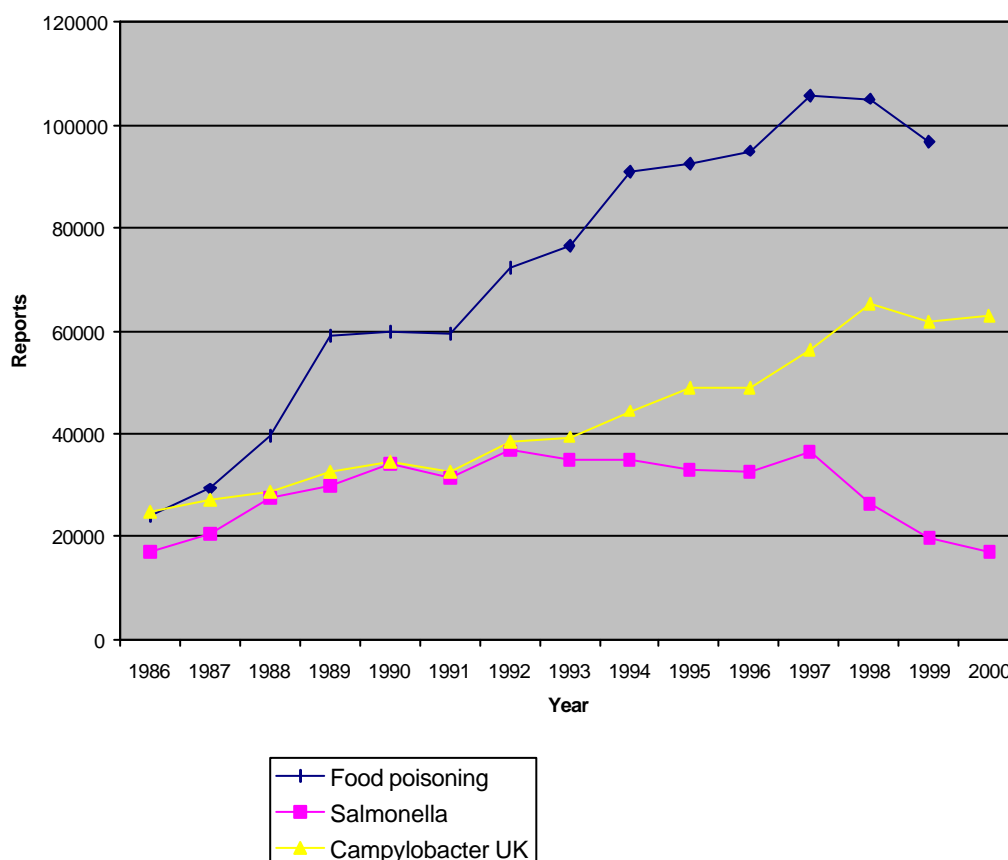
Contents	Paragraphs
Introduction	1 - 7
The main organisms causing foodborne disease	8 - 11
Pathogens causing significant morbidity and mortality	12 – 13
Infectious intestinal disease in infants and young children	14 - 15
The main food vehicles and organisms involved in outbreaks	16 - 22
Measures to control pathogens in foods	23 - 39
Poultry and eggs	24 - 26
Red meat	27 - 31
Dairy products	32 - 36
Other product sectors	37 - 39
Improving food handling and preparation	40 - 54
Catering/hospitality	40 - 47
Food safety in the home	48 - 54
A strategy to reduce <i>Campylobacter</i> infection	55 - 60
Priorities	61 – 69
Plan of Action	70 – 83
Budget	84 - 89
Measuring success: defining the target	90 - 96
The next steps	97 – 98

Annex A: The main organisms causing foodborne disease

Introduction

1. The rising incidence of foodborne disease and the emergence of new microbial threats to the food chain were among the major concerns that led to the decision to set up the Food Standards Agency. Figure 1 shows the trend in statutory notifications of food-poisoning and in laboratory reports of *Salmonella* and *Campylobacter* for the UK since 1986, just before the emergence of the *Salmonella* in eggs problem. Further information on the burden of disease attributable to foodborne disease is contained in a paper presented to the Agency Board in October 2000, entitled "Foodborne disease : developing a strategy to deliver the agency's targets" (FSA 00/05/02).

Figure 1: Notifications of food poisoning and laboratory reports of *Salmonella* and *Campylobacter*



2. The Food Standards Agency has set itself two targets in the area of foodborne disease:

- to reduce the incidence of foodborne disease by 20% by April 2006
- to reduce Salmonella contamination of UK produced retail chicken by at least 50% by April 2005.

The strategy described in this paper is aimed at tackling the first of these. Because it is focussed upon achieving a reduction in foodborne disease, it is not a comprehensive microbiological food safety strategy.

3. Foodborne disease is defined as disease due to consumption of food contaminated with microorganisms or their toxins. Most types of foodborne disease are characterised by symptoms of gastrointestinal infection (also known as infectious intestinal disease or IID). However, not all IID is foodborne. Viral infections, in particular, are usually due to person to person spread. This is important when considering the high incidence of such illness in infants and young children, which is almost entirely due to viral infection. IID in infants and children is considered in paragraphs 14-15.

4. Laboratory reports and outbreak data provide information on the main foodborne pathogens. The strategy focuses on reducing exposure to these, either by measures targeted at individual pathogens in particular foods or by general measures to improve the handling and preparation of foods commercially and in the home. The main foodborne pathogens are defined as those that cause the greatest number of cases and those associated with severe illness and death.

5. Finally, whilst the strategy focuses on achieving the initial 5-year targets, it also aims to strengthen the scientific knowledge base, principally through the funding of research and surveillance, and thus lays the foundation for further control of pathogens in the future.

6. In order to help the Agency develop its strategy, a workshop was held on 21-22 November 2000, involving participants from government, the food industry, retailers, enforcement and the research community, as well as veterinary and public health professionals and consumers. Ideas discussed at the workshop form an important part of the current document, together with recommendations from the Agency's Advisory Committee on the Microbiological Safety of Food (ACMSF).
7. Whilst this is the Agency strategy for the whole UK, it needs to recognise that the priorities for action in the four countries may vary, and hence allow for variations in the approach to meeting the overall target. An example of this may be the higher incidence of *E. coli* O157 in Scotland than in other parts of the UK.

The main organisms causing foodborne disease

8. A large study of Infectious Intestinal Disease (the IID study), carried out in England in 1994/1995, investigated the total number of people in the community with diarrhoea and/or vomiting, whether or not they consulted a doctor. Stool samples from those with symptoms were investigated for a wide range of pathogens and showed which occurred most commonly. The study estimated that a total of 9.4 million people in England suffered symptoms of IID in the course of a year, of which 1.6 million consulted a GP.
9. The major pathogens were:
 - *Campylobacter* (4.3% of all cases, 12.2% of those consulting a doctor),
 - group A rotavirus (4.0% of all cases, 7.7% of those consulting a doctor),
 - Norwalk-like viruses (NLVs) (7.0% of all cases, 6.5% of those consulting a doctor),
 - enteroaggregative *E. coli* (EAggEC) (2.9% of all cases, 5.1% of those consulting a doctor),
 - *Salmonella* (1% of all cases, 5.0% of cases consulting a doctor) and
 - *Clostridium perfringens* (1.2% of all cases, 4.0% of those consulting a doctor).

Further information on these organisms is given in annex A.

10. However, not all of these cases were foodborne. For example, group A rotaviruses are rarely if ever foodborne, whereas *Cl. perfringens* is almost always foodborne. On the basis of outbreak data, it seems likely that over 90% of *Salmonella* infections and about 80% of *Campylobacter* infections are foodborne, whereas this route of transmission probably accounts for only about 10% of cases of NLV infection. Little is known about the sources and modes of transmission of EAaggEC.
11. On the basis of these data, there is a strong argument that the strategy for bringing about an overall reduction in foodborne disease should concentrate on reducing *Campylobacter*, *Salmonella*, *Cl. perfringens* and NLVs.

Pathogens causing significant morbidity and mortality

12. About 1250 cases of *E. coli* O157 are reported each year in the UK. Case control studies suggest that perhaps only half of these cases are foodborne. The number of reported cases of *Salmonella* is about 15 times this figure and the number of reports of *Campylobacter* about 50 times as great. However, *E. coli* O157 causes severe illness and death and so it is appropriate for the strategy to take account of this organism. The action plan at present focuses on measures that have already been recommended by the ACMSF and in the Pennington Report. However, the strategy will be updated in the light of the report of the Scottish Task Force on *E. coli* O157, which was published at the beginning of July 2001.
13. *Listeria monocytogenes* also causes significant mortality (up to 30%), although the total number of reported cases each year is only around 100. Meat and dairy products and fish have been the foods most often associated with infection with this organism. Currently, controls in production are supplemented by advice to those at risk of listeriosis to avoid certain high-risk foods. Efforts will be focussed upon more effective promulgation of this advice. However, proposals currently under

discussion in Europe may, in due course, introduce statutory requirements for the control of *Listeria monocytogenes* in ready to eat foods.

Intestinal infectious disease in infants and young children

14. The incidence of IID in infants and young children is much greater than in older age groups. In the IID study, the rate in children below the age of 5 was about 3 to 4 times the mean rate for the whole study population. The most common pathogens in children under 5 were rotaviruses and NLVs. They accounted for 30% of cases seen by a doctor, compared with 6.5% of cases in adults aged 15-74 years. In infants below the age of 1 year, *Campylobacter* and *Salmonella* each accounted for only 2% of cases visiting the doctor, compared with 17% and 7% respectively in the adult group. In the 1-4 age group, they accounted for 5% and 2.5% respectively. In both groups, foodborne bacteria are uncommon and thus measures directed at foodborne pathogens are unlikely to result in a significant decrease in IID in these age groups.

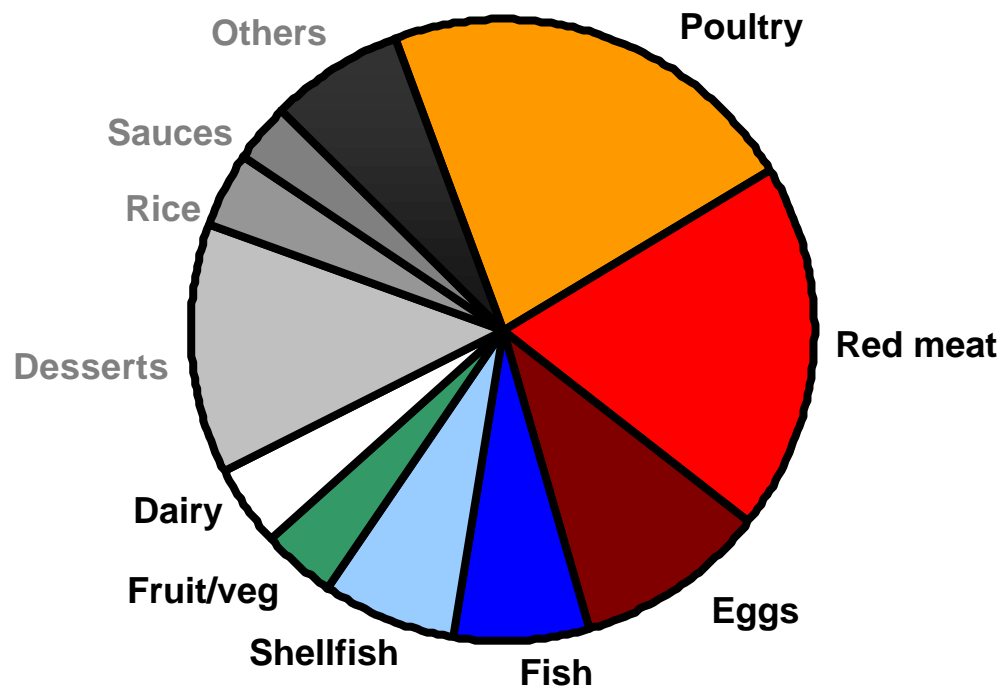
15. However, the IID study did demonstrate the importance of feeding practices in the prevention of IID in infants. Breast-feeding was shown to be strongly protective against IID as a whole, and rotavirus infection in particular. In bottle-fed infants, there was also an association between illness and different methods of cleansing the bottle. When compared with breast-fed infants, babies whose parents cleaned the bottle with cold water and chemicals were three times as likely to suffer from IID whilst those whose parents used boiling water to cleanse the bottle were almost 13 times more likely to suffer IID. Whilst promotion of breast-feeding on the basis of its general protective effect is outside the scope of this strategy, there are food hygiene aspects which may be of relevance to the Agency's target.

The main food vehicles and organisms involved in outbreaks

16. Data from outbreaks suggests broad categories of food where action might best be targeted. The pie chart below (Figure 2) shows the relative contribution of different

food types to 1210 outbreaks between 1992 and 1999 in England and Wales where the likely food vehicle was identified. This chart suggests that the

Figure 2: General outbreaks in England and Wales 1992 - 1999



major areas for intervention are poultry meat, red meat and eggs. As a group, desserts include more than one potential vehicle for foodborne disease. For example, many dessert-related outbreaks involve products made with raw or partly cooked eggs but desserts may also contain dairy products or fruit as the source of contamination.

17. The most common pathogen found in **poultry** outbreaks (30%) and **egg-related** outbreaks (over 90%) was *Salmonella* Enteritidis (PT4). *Cl. perfringens* was also an important cause of poultry outbreaks (over 20%). Over 20% of poultry outbreaks were associated with turkey. Whilst this appears to be broadly in line with the relative amount of turkey that is consumed it may also reflect the problems in cooking large birds thoroughly and in chilling them quickly.

18. For **red meat**, the major single pathogen was *Cl. perfringens* (40%), whilst salmonellas as a group also accounted for about 40% of outbreaks. Beef and pork made the main contribution to the red meat outbreaks (about a third each). Outbreaks due to poultry, eggs and red meat all fell markedly either in 1998 or 1999.
19. Although contributing a relatively small proportion of the total outbreaks, **milk and dairy product** outbreaks are significant because of the high proportion due to *E.coli* O157 (over 25%). Although *Campylobacter* is not commonly associated with recognised outbreaks, it was found in almost 20% of the dairy product outbreaks.
20. The settings associated with outbreaks may indicate where control efforts should be targeted. Unfortunately, the cause of most outbreaks affecting families living together in the same home cannot be ascertained and therefore it is not possible to determine which are foodborne and hence the proportion of foodborne outbreaks attributable to foods prepared in the home. A figure of about 80% has been suggested in studies from Europe, although there are concerns that the methodology used to obtain this estimate is not very robust. If data from general outbreaks only is used (i.e. from outbreaks affecting people who do not live together), home-based catering accounts for about 11% of all foodborne general outbreaks. The majority of general outbreaks of foodborne disease are associated either with restaurants (44%) or hotels (23%), although a significant proportion are also associated with pubs/bars (11%) and caterers (10%). Missing from this data, however, is a denominator showing the relative number of meals consumed in each of these settings.
21. Poultry and eggs accounted for over 25% of the general outbreaks associated with food consumed outside the home and with 45% of outbreaks linked to food prepared in peoples' homes. Desserts were the next most common food associated with outbreaks due to food prepared in peoples' homes (18%) and were also associated with 10% of outbreaks due to food consumed outside the home. Meat and meat products were implicated in 11% and 14% of these outbreaks

respectively. Fish or shellfish were associated with 13% of all general outbreaks, accounting for 17% of outbreaks associated with eating outside the home and 12% of outbreaks linked to food prepared in the home.

22. General outbreaks, whether associated with food consumed outside the home or with food prepared in the home, decreased markedly in 1998 and 1999, in parallel with the general decrease in outbreaks related to poultry and eggs. In both sectors, the number of outbreaks in 1999 was about a third the number recorded in 1997.

Measures to control pathogens in foods

23. Hazard Analysis and Critical Control Points (HACCP) is internationally accepted as the system of choice in the management of food safety in food businesses. It provides a structured approach to managing food safety by controlling hazards inherent in the food handling and production process. It is an approach that is endorsed both by the food industry and the ACMSF. It ensures that proportionate risk based controls are in place and offers the opportunity to reduce unnecessary and prescriptive requirements in legislation. HACCP-based controls already feature in hygiene legislation applicable to certain food sectors, such as retail and catering. Product specific hygiene legislation covering the manufacture of products of animal origin such as meat products, fish products and milk products, also requires the operation of documented “own checks” food safety management systems, which are consistent with the HACCP approach, whilst developments at EU level are likely to result in documented HACCP controls being in place in all EU food businesses within the next five years.

Poultry and eggs

24. The industry has been actively working to reduce *Salmonella* levels in poultry for a number of years. These measures appear to have had a significant effect in reducing cases of *Salmonella* associated with consumption of poultry meat and eggs. Recent developments include the introduction of the Assured Chicken

Production (ACP) Scheme for poultry meat, and the Lion Code and Laid in Britain schemes for laying flocks. The Agency's strategy to reduce *Salmonella* contamination of UK retail chicken (see separate paper) should have a further impact on this. However, these controls appear to have had little effect upon *Campylobacter* contamination. Some of the problems in devising an effective strategy to reduce *Campylobacter* infection are considered below (paragraphs 55 - 60).

25. The ACMSF second report on *Salmonella* and eggs has just been published. The committee considered that the measures taken by the industry (see above) have had a major effect upon the risk of *Salmonella* associated with eggs. A further egg survey is planned, to be carried out later this year, in order to investigate current levels of *S. Enteritidis* contamination. Industry data suggests that these are now very low. It may also indicate the extent to which any further reduction in salmonellosis is possible as a result of improvements in the primary production sector. The ACMSF believes that a key to improved control has been vaccination of layer hens. The extent to which control programmes that do not include vaccination provide an equivalent level of protection is not clear, although the egg survey may provide some information on this. Other recommendations from the ACMSF report will be considered when elaborating this strategy.

26. At the foodborne disease workshop, the eggs sector group suggested a sector specific, tailor-made food hygiene training initiative, preferably in IT form to allow "on-site" training. The group also suggested that an enhanced role for the Egg Marketing Inspectorate (in the investigation of egg related outbreaks and enforcement) should be considered.

Red meat

27. The main priorities which need addressing in the red meat sector are the control of *Salmonella* and *E. coli* O157. The principal current control measure is the clean livestock policy, i.e. the policy of rejecting animals presented to the slaughterhouse

with evidence of faecal soiling. Evidence from surveillance studies allowing a comparison of the proportion of animals carrying pathogens prior to slaughter with post-slaughter carcase contamination levels suggests that a relatively small proportion of carcasses become contaminated with gastrointestinal pathogens during slaughter and dressing. However, a more formal evaluation of the effectiveness of current policies may be warranted. Although there is not a stage during the slaughtering process at which pathogens can be eliminated, hygiene controls in the slaughterhouse based on HACCP principles target those stages where contamination with pathogens is most likely to occur. The effectiveness of these controls can be verified by means of microbiological testing for faecal organisms. Approaches that might result in reduced faecal carriage in animals prior to slaughter are still at a research stage. These include the development of vaccines and the investigation of pre-slaughter feeding practices that may affect carriage and shedding.

28. *Cl. perfringens* also shows a significant association with meat dishes. However, this is related to errors in food processing and preparation rather than the presence or absence of the organism in food animals. The organism is part of the normal intestinal flora of a range of animals, including humans. It is also ubiquitous in the environment. It only causes illness if handling errors during food preparation, cooking and storage allow spores to survive, germinate and multiply. If subsequent re-heating is inadequate, ingested organisms will sporulate and produce toxin. Reduction of faecal contamination of carcasses should reduce contamination with this organism, but this is unlikely to reduce the exposure of the consumer to any significant extent.

29. Recent surveillance studies in food animals have underlined the fact that sheep and cattle are significant carriers of *Campylobacter jejuni*, whilst pigs have a very high carriage rate of *Campylobacter coli*. Whilst studies to date have not demonstrated significant associations between red meat consumption and *Campylobacter* infection, raw meat may serve as a source of organisms that cross-contaminate

other foods and the possible contribution of this sector to the control of campylobacteriosis should not be overlooked.

30. These surveillance studies also showed a significant level of carriage of *Yersinia* spp. The extent to which this contributes to human illness in the UK is unclear. *Yersinia* was found in over 3% of cases in the GP case control component of the IID study. However, it was found equally frequently in control subjects with no symptoms. Further work to investigate the pathogenicity of the strains isolated in the study and compare animal and human isolates appears to be necessary. Cases of yersiniosis reported through the routine laboratory reporting system have fallen markedly since the early 1990s. However, culture may not be the gold standard for detection of illness due to this organism. Serological results from patients with reactive arthritis suggest a higher number of cases than culture alone. Adhering to hygienic dressing procedures during slaughter will assist in reducing the risk of carcase contamination.
31. Red meat is a potential source of the parasite *Toxoplasma gondii*. However, the ability to detect acute cases in humans is limited and it is not therefore feasible to include this pathogen in the overall foodborne disease figure.

Dairy products

32. Controls in the dairy sector could contribute to the control of a range of pathogens including *Campylobacter*, *Salmonella*, *E.coli* O157 and *Listeria monocytogenes*. Pasteurisation is the main current control measure for milk. Outbreaks have been associated with raw milk, raw milk products, and with milk that has been inadequately pasteurised or subject to post-pasteurisation contamination.
33. The ACMSF recently considered results from a national survey of the microbiological quality and heat processing of cows' milk. Members expressed concern that a number of pasteurised milk samples had been found to contain coliforms, *E. coli* and, in some cases, potential pathogens. These clearly showed

that a small number of dairies need reminding of the steps required to ensure that pasteurisation, a highly effective process when done properly, is correctly carried out on every occasion. The Committee recommended that the Food Standards Agency discuss with industry the unsatisfactory nature of some of the results, with a view to achieving the required improvement. Any discussion should also include on-farm pasteurisation about which there has been concern in the past.

- 34.Reduction of risk associated with raw milk and raw milk products requires care in monitoring the source of the milk, and scrupulous hygiene during milking and manufacture. The ACMSF has recommended that all drinking milk should be pasteurised on public health grounds. In Scotland, this is already a requirement.
- 35.The milk and dairy product group at the workshop considered that a key requirement was for existing controls to be better applied. Notably, there should be more prescription in the arrangements for pasteurisation (perhaps including certification of the proper functioning of pasteurising equipment), sampling frequencies should be increased and should be specified, and adequate arrangements should be made for notifying the enforcement authorities of milk test failures, including the results of coliform testing by milk buyers' laboratories.
- 36.Apart from better application of existing legislation, the group considered that key strategies to control pathogens in this sector include sound implementation of HACCP principles, to control processes and post processing cross contamination, and ensuring effective communications between the relevant enforcement authorities so that breakdowns are effectively controlled.

Other product sectors

- 37.There have been a number of significant outbreaks associated with **meat products**. These may be due to pathogens present in the raw meat used to prepare the product. These pathogens may survive if the product is inadequately cooked, or may give rise to cross-contamination from raw to cooked product. Another

important pathogen found in meat products is *Listeria monocytogenes*. This is a ubiquitous organism in the environment and the source of contamination is often found to be the factory environment. Like other sector groups, the meat product and butchers' group at the foodborne disease workshop highlighted the importance of focused training, together with user-friendly guidance and promotion of hazard analysis, as key priorities.

38. Most of the outbreaks associated with **shellfish** are of unknown aetiology, although they are assumed to be viral. In addition to NLVs, shellfish may be responsible for transmission of hepatitis A. Toxins, such as scombrototoxin and algal toxins, also contribute to foodborne illness associated with fish and shellfish. Although an important cause of illness in other countries, vibrios rarely cause disease in the UK, whilst *Salmonella* is now only rarely associated with shellfish in this country. Overall, fish and shellfish are thought to make a fairly small contribution to the burden of disease. There are a large number of existing statutory controls which no doubt play their part in this. The key to the control of shellfish-related illness is the quality of water in harvesting areas, backed up by monitoring programmes for microbiological quality and algal toxins. Improved methods of monitoring, particularly for viral contamination, are being developed.

39. Many **fruit and vegetable**-related outbreaks are known or presumed to be due to viruses and, as such, are related to food handler problems. However, pathogens present in organic fertilisers or irrigation water may result in cases or outbreaks of *Salmonella*, *Shigella* and *E.coli* O157. Programmes of research to underpin risk assessments of the use of organic wastes and to investigate the effects of irrigation water on contamination are currently in hand. The ACMSF has recently reviewed this area and concluded that although evidence at present does not suggest that contamination during primary production is a major cause of illness, the potential risk associated with fruit and vegetables needs to be kept under regular review. This was underlined by two large outbreaks of *Salmonella* Typhimurium last year, which were associated epidemiologically with lettuce and salad vegetables used in fast-food fillings. Investigations suggested that the lettuce was imported, although it was

not possible to prove this. Imported lettuce was also incriminated in an outbreak of *Shigella sonnei* several years ago. These outbreaks serve to highlight the potential risk from imported produce which, in the case of fruit and vegetables, has a share of the market that varies considerably with the season.

Improving food handling and preparation

Catering/hospitality

40. Whilst the contribution of the catering/hospitality sector to outbreaks is broadly known, its contribution to sporadic disease is not. Whether or not enhanced approaches to the investigation of IID or analytical studies will enable this contribution to be assessed remains uncertain. With the increase in eating out, involving a wide range of different types of business, the contribution of this sector to the overall disease burden may well have increased and, in the absence of effective controls, would be expected to increase further. As described above, outbreak data indicate the types of food that are most likely to give rise to problems and also the type of errors that are considered responsible, namely, inadequate cooking, inadequate chilling and cross contamination.

41. In addition to the organisms found in the food ingredients, food handlers may introduce viruses and *Staph. aureus*, whilst food handling errors may result in proliferation of and toxin production by *Cl. perfringens* and *B. cereus*. Thus effective controls in this sector have the potential to reduce foodborne disease of all types.

42. The approach of first choice for controlling hazards in this sector is HACCP. However, there are a number of barriers to uptake, particularly amongst smaller and less developed enterprises. The ACMSF recently considered the reasons for this. It was noted that the formal HACCP system was less well adapted for use by such businesses, who often had difficulties understanding what was required. HACCP plans may also be overcomplicated, documentation requirements may be

burdensome and training costs may be high in relation to resources and staff turnover.

43. The Committee agreed that simplified, sector-specific generic models should help smaller and less developed businesses attain acceptable levels of risk control. Members felt that the production of generic model guidance would best be taken forward by industry bodies, with input as necessary from enforcement authorities. The Committee saw a coordinating role for the Food Standards Agency.
44. The Agency is funding a research programme on the management of microbiological hazards and risks, which is looking at ways of encouraging the uptake of HACCP and also at food handlers' knowledge, beliefs and attitudes. Ideas emerging from this programme include the establishment of HACCP resource centres and the possibility of recognising enterprises as centres of excellence.
45. The catering group at the foodborne disease workshop suggested a variety of approaches to improving food safety in this sector, recognising that all depend upon bringing about a change in culture and attitudes. Measures might include the provision of guidance and support for businesses, support for enforcement (perhaps including licensing and the publication of inspection outcomes), and incentives for compliance. Whilst management systems were recognised as key, underpinned by management commitment to food safety, the group also identified the need to explore the sourcing of ingredients and ways of facilitating sourcing from reputable suppliers.
46. In its 1998 report on Foodborne Viral Infections, the ACMSF recommended that the Joint Committee on Vaccination and Immunisation (JCVI) should keep the question of hepatitis A vaccination of food handlers under review. When this was subsequently considered by the JCVI, that committee did not consider that the evidence justified routine hepatitis A vaccination of food handlers.

47. The raising of awareness of food hygiene in this sector forms a part of the communications strategy supporting the foodborne disease strategy. It may be necessary to develop a series of tailored messages. For example, the precautions that will prevent outbreaks of *Cl. perfringens* (fast and thorough cooling of bulk dishes and adequate re-heating) are very different from those that will reduce the risk of contamination with NLVs (hand-washing, appropriate steps to deal with nausea and vomiting).

Food safety in the home

48. Like the catering/hospitality sector, the overall contribution of domestic food preparation to sporadic cases of foodborne disease is unknown, and possibly unknowable. As mentioned above, about 11% of general foodborne outbreaks are associated with food prepared in the home for extended family or community events. Poultry, eggs and desserts were the main food vehicles in these outbreaks.

49. Effective controls in this sector have the potential for reducing foodborne disease of all types. This includes infections due to food contaminated with *Salmonella*, *Campylobacter* and *E. coli* O157, infections due to organisms derived from food handlers (viruses and *Staph. aureus*), and illness due to toxins formed by *Cl. perfringens* or *Bacillus*. However, the potential for the rapid improvement in the control of cross contamination in this environment should not be overestimated, requiring, as it would, a fundamental change in attitudes and habits, and considerably increased vigilance in what is largely an informal setting. Moreover, the question has been raised as to whether it is possible in the domestic setting to avoid cross contamination with pathogens such as *E. coli* O157 and *Campylobacter* that have a low infectious dose, particularly when raw products are heavily contaminated.

50. The research programme mentioned in paragraph 44 is also investigating the relationship between knowledge, beliefs and attitudes, and the preparation of food in the home. Work is now being carried out to see whether social marketing

approaches, the “selling” of food hygiene messages based on approaches used in selling commercial goods, can be used to affect behaviour in the kitchen.

51. The group considering the domestic sector at the foodborne disease workshop recommended a major integrated advertising campaign consisting of two steps: branding the message and targeting the message. The branding would require professional marketers working with the relevant agencies to generate a consistent simple slogan which would then be promoted through lifestyle-type advertising over a period of several years. This branding of the message would form the basis for initiatives to target the message to different audiences, using a range of media.
52. An effective campaign of this sort would require a higher level of funding than is currently available. However, if it were thought important to pursue this course, some of the agreed funding could be used to pilot some of the ideas first. This would fit into an overall communication strategy, whereby the main communication initiative in the first year would be directed towards small catering businesses, and other audiences, including the public at large, would be targeted at a later stage.
53. The group also recommended that this approach should be reinforced by the training of key professionals to be mediators for the message and compulsory inclusion of food hygiene in the school curriculum. A further aim should be to build a market for kitchen equipment designed to encourage good hygiene standards and practice.
54. Results from the IID study suggest that promotion of breast-feeding in association with colleagues in the Health Departments should also be pursued, together with appropriate advice on hygienic preparation of feeds and cleansing of bottles where breast-feeding is not pursued. Whilst most of the illness that is potentially preventable in this way is not foodborne, the differences seen in risks associated with different methods of bottle cleansing suggest that there is a food contamination component that needs to be addressed.

A strategy to reduce *Campylobacter* infection

55. *Campylobacter* is the major cause of IID in those consulting a doctor and it is also the most common gastrointestinal pathogen reported by laboratories. A significant reduction in campylobacteriosis would therefore make a major contribution to achieving the Agency's target. However, although poultry meat is known to be frequently contaminated with *Campylobacter*, it may not be the only important source of this organism and may not be the primary vehicle of infection in all cases. Typing methods are now available that allow a better study of the relationship between human and poultry strains of *Campylobacter*. Some collaborative work between PHLS and the VLA is already in hand and this needs to be actively promoted, as well as studies of potential sources of the organism other than poultry.
56. The lack of outbreak data has affected the ability to study the epidemiology of *Campylobacter*. The PHLS has established a laboratory-based *Campylobacter* sentinel system. This may help to identify more clusters for investigation and is already generating hypotheses about risk factors for sporadic cases which, together with improved typing methods, should result in more informative epidemiological studies.
57. Biosecurity measures that have proved effective in controlling *Salmonella* in poultry have not met with similar success in controlling *Campylobacter*. However, the poultry group at the foodborne disease workshop considered that there were a number of areas worthy of further investigation, including the effectiveness of "gold-plated" biosecurity, crate washing, identification of critical control points in processing, thermal decontamination, chemical decontamination and the use of deep chill storage or modified atmosphere packaging. The group also considered that the potential role of irradiation should not be forgotten, although the strength of consumer feeling against this technology was acknowledged.

58. The mapping of the *Campylobacter* genome should facilitate the identification of pathogenicity factors and targets for interventions such as vaccines. However, the genome work has highlighted the hypervariability of the *Campylobacter* genome, suggesting that development of an effective vaccine may prove elusive.
59. Following publication of the ACMSF's interim report on *Campylobacter*, the Government funded a considerable body of research, much of which has now been completed. The Committee plans to hold a meeting later in the year to take stock of the research, and to identify any fresh initiatives or changes of direction that are required. A summary of the publicly-funded research, put together by the Microbiological Safety of Food Funders' Group, is available on the Agency website.
60. In summary, there is a need for investigations to be carried out in a number of areas in order to identify ways of reducing *Campylobacter* contamination of food and the most important food sectors for targeting interventions. This is likely to lay the foundation for a longer term strategy to reduce foodborne campylobacteriosis. However, in the meantime, initiatives aimed at improving food hygiene in catering and in the home, focussing on thorough cooking and the prevention of cross-contamination, should bring about a reduction in cases of campylobacteriosis, and there may also be some reduction as a result of hygiene initiatives in the poultry, red meat and dairy sectors.

Priorities

61. The most significant reduction in the number of cases of foodborne disease over the next five years is likely to come from **focussing attention on food preparation**. Indeed, viral infections (with the exception of those related to consumption of shellfish) and cases of foodborne disease due to *Cl. perfringens*, staphylococcal and *Bacillus* toxins can only be controlled by action at this level. Whilst controls in the food production sector can make a contribution to the control of *Campylobacter* infection, the greatest reductions in campylobacteriosis at present are also likely to

be brought about by action in the catering and domestic settings. Hence efforts need to be concentrated on these sectors.

62. **Wider implementation of HACCP principles** in food businesses needs to be a major component of any foodborne disease strategy. Linked to this should be a **communication strategy**, to raise food hygiene awareness amongst all food handlers. This should be the principal way of reducing risks in the catering sector.

63. Action in the home also requires a **communications initiative**, such as that outlined in paragraphs 51 - 53, coupled with continuing research into effective ways of conveying messages and promoting safer food handling practices.

64. Some sectors of the food industry have done much in recent years to reduce microbial contamination in foods. For example, there has been significant success in the control of *Salmonella* in the last three years associated with controls in the poultry industry. Human cases have fallen by over 50%. However, the **production sector** can still make major contributions to achieving the overall target, including a further reduction in human cases of salmonellosis. This is closely linked to the **chicken target**, although some consideration should be given to controls in turkey production and the scope for further measures in the egg industry.

65. Other priorities in food production are efforts to control ***E.coli* O157** in the red meat and dairy sectors and initiatives to reduce the risk of ***Listeria*** contamination of ready-to-eat foods.

66. **Training, education and user-friendly guidance** were key requirements identified by all sector groups at the foodborne disease workshop. Consideration should therefore be given to ways in which the Agency can support the construction of an effective UK-wide training network, across sectors of the food industry, in partnership with other organisations.

67. **Partnerships** need to be developed with a wide range of stakeholders to deliver the strategy. This includes other government departments, including DEFRA, DH and DfEE. In particular, aspects of consumer education, particularly education of children, need to be pursued in partnership with DfEE within the context of the Agency's overall agenda for the promotion of safe and healthy eating in schools.
68. Further **research** to help develop an on-going strategy for reducing foodborne disease is the final component of the strategy. In particular this is required to lay the foundation for better control of **campylobacteriosis**.
69. Evaluation of results from existing programmes of research on, among other things, organic waste, irrigation water, control of viral foodborne disease and microbial risk assessments may result in the modification of priorities or introduction of new methods of control in the course of the 5-year strategy and further modifications may also be necessitated in the light of the results of implementation of the strategy in its first couple of years. The strategy may also need to be modified to take account of advice, such as the report from the *E. coli* O157 Task Force in Scotland. It will also need to respond to the emergence of new problems, including new organisms.

Plan of action

70. As a result of the Workshop, discussions within the Agency and research work, a series of measures have been identified in each sector. These measures will be implemented over the five-year period of the strategy although it must be recognised that they will need to be in place well before the end of the 5-year period, in order to deliver the target and that availability of funding beyond the current CSR period is, of course, unknown. Whilst activities and initiatives will proceed across a wide front, the action plan places particular emphasis on securing improvements in high risk sectors. Since the measures that will help control one organism will not necessarily have an impact on others, figure 3 provides a grid showing which of the proposed parts of the action plan contribute to the control of each pathogen.

Figure 3: Main foodborne pathogens and measures aimed at their control

	<i>Campylobacter</i>	<i>Salmonella</i>	<i>Clostridium Perfringens</i>	<i>E. coli</i> O157	<i>Listeria monocytogenes</i>	NLVs
Catering/domestic messages						
- cooking	+	+	+	+		
- cross-contamination	+	+		+		
- cooling		+	+			
- hand washing etc	+	+		+		+
Poultry meat	+	+				
Red meat	(+)	(+)		+		
Meat products				+	+	
Milk and dairy products	+	+		+	+	
Eggs		+				
Shellfish						+
Fruit and vegetables		+		+		

71. The strategy will build upon control measures that are already in place and which have, in some cases, already yielded significant improvements in the microbiological quality of food reaching the kitchen. In some sectors, notably the poultry and eggs sector, this has been mirrored in a reduction in human cases of illness.

72. There will need to be a comprehensive integrated marketing and advertising campaign to support the strategy and Communications Division will be submitting a separate paper to the Agency Board outlining its recommendations in due course. As part of the campaign, we will be looking for strategic partnerships and there will

need to be a relationship between any campaign activity and the Board's priorities for HACCP. We have also set up a high level leadership group consisting of industry, enforcement and education partners. We anticipate a concentration on the catering sector in the first year and we will pilot and research consumer approaches before making formal recommendations for the second and third years of the campaign. However, all campaign activity will be closely evaluated.

73. The enforcement aspects will be taken forward within the framework of the Agency's enforcement strategy. The Agency's Framework Agreement on local authority food law enforcement is at the centre of this strategy. The Agency will be proactive in setting and monitoring standards and auditing local authorities' enforcement activities against the standards in the Framework Agreement in order to ensure the necessary activities are taking place effectively and in line with any agreed national food safety enforcement policy. Information generated by monitoring and audit activity will have a valuable role to play in informing future policy development.

Catering/hospitality sector

74. The main aim is to ensure that businesses have effective food safety management systems in place. Measures designed to achieve this will include:

- publicity campaigns to raise awareness and understanding of effective food safety management systems aimed mainly at small and less developed businesses
- a range of initiatives to support implementation of effective food safety management systems in catering businesses, which may include:
 - development of model guidance appropriate for different types and sizes of business, possibly modelled on the existing suite of Industry Guides to Good Hygiene Practice

- pilot schemes to test the effectiveness of specific approaches to supporting HACCP implementation, including training courses and local resource/advice centres
- promotion of existing good HACCP practice, particularly in small businesses, using example 'beacon businesses'.
- initiatives will have to take account of the circumstances and needs of ethnic catering businesses
- effective enforcement
- agreement of timescales for implementing successful HACCP-type schemes in food premises with the industry.

In the home

75. The main activities will be:

- a high profile media campaign to stimulate public interest and then to deliver key messages
- development and implementation of training for key professionals (such as nurses, health visitors, teachers, social service providers)
- development of effective communication programmes for potentially vulnerable groups of the population (for example, households on low income, the elderly), based on approaches being piloted in current research work
- negotiating with DfEE regarding the inclusion of food hygiene in the school curriculum as part of a safe and healthy eating package
- discussion of initiatives to promote breast-feeding and better hygiene in the preparation of infant feeds and cleansing of bottles with the health departments.

Poultry meat sector

76. The main activities in this sector will arise from the strategy to deliver the Agency's poultry meat target. The priority areas are likely to be:

- baseline poultry meat survey (2001), plus follow up surveys to monitor progress (2003/2004) and to assess achievement of the *Salmonella* target (Spring 2005). As well as setting the baseline for the *Salmonella* target, it is anticipated that the initial survey will also help to focus on the measures required to achieve the target
- promotion of best practice throughout the poultry industry.
- strengthening of existing industry measures by co-operating with, and supporting, the Assured Chicken Production scheme.
- production of guidance/codes of practice. There are areas where it has been highlighted that enhanced guidance or the provision of Codes of Practice would be beneficial in helping to reduce salmonella contamination. Those identified to date include measures to minimise salmonella contamination in feed mills and mid-crop testing.
- review of crate washing. The difficulties in washing/decontaminating poultry crates are well known. Whilst it is not possible to quantify the role that this plays in the spread of salmonella it is clear that this is an area which needs further investigation.

77. Several areas, affecting both *Salmonella* and *Campylobacter* control, have been identified where information may become available, or work needs to be put in place, that could be used before the end of the 5-year period.

- systematic investigations of routes by which *Salmonella* or *Campylobacter* may enter poultry houses and persist in them, and development of effective methods of controlling them.

- comparative studies of *Campylobacter* negative and *Campylobacter* positive houses.
- study of the effects of thinning (removal of birds during the rearing period to avoid overcrowding).
- study of the samples taken and the results obtained during the passage of chickens through the slaughterhouse, in order to develop practical advice on sampling and on minimising cross-contamination.

78. Other areas of research will be considered but are unlikely to deliver practical control measures within the five-year period. These include:

- development of practical ways of minimising cross-contamination via the scald tank water during commercial processing.
- direct control measures for controlling *Campylobacter*, including vaccination or competitive exclusion.

Red meat

79. The main initiatives here will be:

- measures to improve ante-mortem inspection, e.g. improve ante mortem training for Official Veterinary Surgeons.
- measures to improve post mortem inspection. Action in this area will very much depend on legislative changes currently the topic of discussion in Brussels.
- securing implementation of HACCP in slaughterhouses in line with EU requirements.
- enhanced monitoring of compliance with clean livestock policy
- to review and consolidate existing guidance on the management of outbreaks

Meat products, minced meat and meat preparations

80. The main activities here will be:

- Review guidance on the enforcement of the hygiene legislation applicable to premises manufacturing these products, particularly in respect of 'own checks', to ensure that existing controls are operating effectively
- Consider initiatives to increase the application of the 7 HACCP principles in meat products, minced meat and meat preparations establishments.

81. The availability of appropriate and consistent **HACCP training** for both industry and enforcement officials will be an important factor in supporting the wider application of the HACCP principles by the food industry. The main activities here will be:

- Continue to work with the national awarding and accreditation bodies to encourage and facilitate the development of appropriate and accessible HACCP training courses and materials for industry
- Continue to facilitate the work of the independent HACCP Training Standards Steering Group in the development of voluntary national standards for HACCP training courses
- Continue to provide seminars and training on HACCP and on the interpretation, application and enforcement of the regulations for food law enforcers.

Milk and dairy products

82. The main activities in this sector will be to:

- review responsibility for, and the approach to, enforcement of dairy products hygiene legislation at approved establishments pasteurising milk on farms
- run pasteurisation workshops for EHOs where appropriate

- continue to operate the food safety management awareness initiatives for on-farm pasteurisers and on-farm milk product producers
- operate a food safety management awareness initiative for specialist cheesemakers
- review guidance on the enforcement of dairy products hygiene legislation, particularly in respect of 'own checks', to ensure that existing controls operate effectively
- review the function of the Dairy Hygiene Inspectorate, and equivalent enforcement authorities in Scotland, in relation to the need to reduce the risks of faecal contamination of milk during milking
- consider initiatives to increase the application of all 7 HACCP principles in processing
- publicise effects of diets on pathogen excretion
- ensure effective communications between the relevant enforcement authorities so that breakdowns are effectively controlled
- consider ways of ensuring the results of milk test failures and of coliform testing by milk buyers are transmitted to the enforcement authorities
- encourage development of a quick method to test for coliforms

Other food product sectors

83. The following activities will be undertaken in the egg, shellfish and fruit & vegetable sectors:

Eggs:

- Survey of eggs on retail sale
- Bring together data on microbiological quality from different sources
- Development of sector specific, tailor-made, food hygiene training initiative (possibly using a CD-ROM approach) covering:
 - Personal hygiene
 - Cleanliness

- Pest control
- Quick collection
- Further education on issues such as cross-contamination - between eggs and other species.
- Encourage HACCP in businesses not currently covered by an assurance scheme
- Seek ways of involving the Egg Marketing Inspectorate in egg related outbreaks and further enforcement powers at retail level

Shellfish

- Review approach to monitoring of harvesting areas so that it reflects changes in water quality in a timely fashion.
- Develop and introduce better controls for viral contamination and improved testing procedures for biotoxins.
- Strengthen local communication through continuing targeted training for EHOs, updating guidance and codes of practice and supporting local shellfish liaison groups.
- Improve water quality through targeted investment under AMP 3 programme for investment by water companies. This a DETR lead strategy which the Agency will support because of the benefits to shellfisheries.
- Improve investigation of shellfish outbreaks.

Fruit and vegetables

- Produce guidance for farmers on the use of manures in agriculture to minimise the risks to food safety. The Agency has gathered together a group of people who have expertise in this area to develop this guidance. The aim is to have a draft document to go out to consultation by the end of 2001.
- Develop the guidance in the light of a risk assessment on the spreading of animal wastes (manures and abattoir waste) on agricultural land. The

Agency is funding a microbiological risk assessment to examine the risks to food safety associated with the spreading of manure and abattoir waste on agricultural land. This should be completed in 2002 and the outcome will be used to assist in the development of guidance for farmers.

- A review of the use of water in UK agriculture and the potential risks to food safety. The Agency is funding a review on the use of water in agriculture and the potential risks to food safety. The results of the review will be used to assess the potential for guidance for farmers aimed at minimising the risks to food safety from the use of water for irrigation and other purposes.

Budget

84. The CSR2000 grant consists of £4m for 2001/2002, and £8m for 2002/2003 and 2003/2004. This is to cover UK-wide activities to achieve both foodborne disease targets. A line-listing for measures to deliver the *Salmonella* in chicken target has been included although a number of these will also contribute to the achieving of the general foodborne disease target. Further details of this budget will be found in the separate strategy for reducing *Salmonella* in chicken. Since the target for reducing foodborne disease is to be achieved over a five-year period, although much of the expenditure to meet it will be spent in the first three years, some of this expenditure will need to be maintained in the remaining two years. Funding shown in squared brackets will need to be identified for this purpose.

85. Current commitments from the MSD research budget for 2001/2002 are in the order of £4.8m against a budget of £4.4m. Much of this expenditure is on work of direct relevance to this strategy. Work of this sort that is already being funded, or which is about to be funded, is not included in the budget for the strategy. The budget for 2001/2002 is already fully committed. However, if current levels of research funding continue, it can be assumed that each year about £1.4m of new projects can be

funded. Whilst much of this work will not deliver results in time to make a difference over the five-year period or may not be of direct relevance to the proposed strategy, it seems reasonable to allocate some funding from this source in the second and third years of the strategy. The second and third year budgets have been increased by £500K to reflect this.

86. A further £900K per year has been added to the budget. This represents £800K per year from the MSD surveillance budget and £100K in the existing Scheme budget for milk and milk products. The latter sum appears as “food safety management initiatives”. Other existing expenditure, which will help to achieve the targets, including expenditure in the devolved areas, is not included here.

87. Enforcement activities that will support the target are not included in the budget. Funding for HACCP in non-high risk businesses will require additional resources, which might include licence fee income. This is indicated by an asterisk in the table.

88. A budget of £5.5m has been allocated over the three year period for the publicity campaign directed at the general public. In the first year, this is intended to fund preliminary development and piloting work. However, this is the minimum requirement for a consumer campaign and an effective media campaign over the whole 5-year period could cost far more. The development work should help define the costs more fully. The Agency will seek to match funding through its development of strategic partnerships.

89. Some additional posts have been agreed as necessary to support the target work. Since the post-holders cannot be allocated to individual sectors, the total cost is itemised separately. Further dedicated communication staff will be required if an effective media campaign is to be launched.

	2001- 2002 £m	2002- 2003 £m	2003- 2004 £m	2004- 2005 £m	2005- 2006 £m
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Human surveillance	0.17	0.2	0.2	0.2	0.4
Catering/hospitality	2.5	3.0	3.0		
- publicity	2.0	1.5	1.5		
- HACCP (high risk)	0.5	1.5	1.5		
- HACCP (others)	*				
- enforcement	*				
Domestic	0.5	3.0	3.0		
- publicity	0.5	2.5	2.5		
- training of professionals		0.5	2.5		
Poultry meat	0.8	1.0	1.0	0.3	0.2
- surveillance	0.2		0.1	0.3	0.2
- <i>Salmonella</i> in chicken strategy	0.3	0.4	0.3		
- HACCP	0.1	0.3	0.4		
- research / development	0.2	0.3	0.2		
Meat/meat products	0.2	0.9	0.9	0.2 / [0.7]	0.1 / [0.5]
- HACCP	0.2	0.5	0.4	[0.4]	[0.2]
- training		0.3	0.3	[0.3]	[0.3]
- surveillance		0.1	0.2	0.2	0.1
Milk/milk products	0.4	0.9	1.0	0.1	0.1
-pasteurisation training	0.1	0.1	0.1		
- consultancy services	0.1	0.1	0.1		
- HACCP	0.1	0.3	0.3		
- research/development		0.2	0.2		
- surveillance		0.1	0.2	0.1	0.1
- food safety management initiatives	0.1	0.1	0.1		
Eggs	0.2	0.3	0.2		
- survey	0.2				
- training package		0.1			
- HACCP		0.2	0.2		

Shellfish					
- seminars					
Fruit & vegetables	0.03				
Additional staff	0.1	0.1	0.1	[0.1]	[0.1]
Total	4.9	9.4	9.4	0.8	0.8

Measuring success : defining the target

90. The main measure of success will be achieving the target of a 20% reduction in foodborne disease. However, there is no single, all-encompassing measure of foodborne disease. There are several reasons for this:

- although most foodborne diseases produce gastrointestinal symptoms such as diarrhoea and vomiting, some do not (e.g. listeriosis, hepatitis, toxoplasmosis etc.)
- not all infections that cause diarrhoea and vomiting are foodborne
- most cases of infectious intestinal disease are not linked to others in an outbreak, so it is rarely possible to establish whether or not they are foodborne.

91. The most obvious measure of the target might appear to be statutory notifications of food poisoning or suspected food poisoning. However, this is not a reliable measure. It is based on the opinion of the notifying physician and requires neither microbiological demonstration of a foodborne pathogen, nor epidemiological evidence to support the attribution. Therefore statutory notifications will **not** be used to monitor progress towards achieving the target.

92. An approach that has been taken in the USA is to use data from laboratory surveillance to try and estimate the total number of cases of foodborne disease. However, this approach necessitates making assumptions about the proportion of

cases identified through the laboratory reporting system and the proportion of cases likely to be foodborne, not only for each of the known pathogens but also for cases with no identified target organism. The PHLS Communicable Disease Surveillance Centre (CDSC) and the Scottish Centre for Infection and Environmental Health (SCIEH) are drafting a paper based on this approach. Publication will enable the approach to be subject to scrutiny and debate. However, it does not yet have the scientific support necessary to advocate the Agency's using it to monitor the foodborne disease target.

93. The IID Study has shown that a relatively high proportion of cases due to the major bacterial foodborne pathogens are detected by the laboratory reporting schemes operated by the four national surveillance centres. The Agency therefore intends to measure its foodborne disease target on the basis of UK laboratory reports of the major bacterial causes of foodborne disease, namely *Campylobacter jejuni*, *Salmonella* spp., *Clostridium perfringens*, *E. coli* O157 and *Listeria monocytogenes*.

94. The only agents causing an appreciable amount of foodborne disease that are not included in this measure are NLVs. At present it is considered that, whilst the strategy does include measures aimed at reducing the incidence of foodborne viral infections, it is not appropriate to include them in the target. This is for two reasons. First of all, current laboratory methods detect only a very small proportion of all NLV infections (the IID Study estimated 1 in 1500). This is because few samples are examined by electron microscopy (EM) and, when they are, the chances of making a positive diagnosis are small because, after the first couple of days of illness, viruses are no longer detectable on EM. New molecular methods of diagnosis are likely to become available within the next few years which will facilitate routine examination for NLVs and detect them for weeks rather than days. This may enable us to establish a realistic baseline. Secondly, although NLVs accounted for 6.5% of cases consulting a doctor in the IID study, outbreak data suggests that only 10% of these are likely to have been foodborne. Therefore, if laboratory methods do improve detection and diagnosis of NLV infection, the results will need to be

considered separately from the target figure for bacterial pathogens, where the majority of cases are thought to be foodborne. This is an area that will be kept under review as the strategy develops.

95. Because of the way in which the baseline is expressed, it will be possible to monitor progress towards the target on an annual basis. The detailed plans of action for the individual sectors, which will be drawn up on the basis of the action plan described above, will also contain both milestones to indicate progress and process indicators.

96. The quality and consistency of laboratory reporting is crucial not only to a measurement of the target based on the number of laboratory reports of key pathogens but also to the model being developed by CDSC and SCIEH. The system is vulnerable to changes in GP consultation, GP stool sampling practice and laboratory operating procedures. Independent markers to signal changes of this sort will be monitored, such as the use of sentinel practices linked to sentinel laboratories.

The next steps

97. Following the Board's agreement of this strategy, detailed action plans for the individual components are being drawn up in discussion with stakeholders throughout the UK. In some cases, the measures identified will be implemented as a part of other Agency strategies, such as the communications strategy, the Local Authority enforcement strategy, and the strategy to deliver the *Salmonella* in chicken target. A UK consultative group, consisting of experts, enforcers, industry and consumers, under the chairmanship of Agency officials, is being set up to act as a sounding board for the wider stakeholder community and to provide advice on the proposed plans of action.

98. The strategy concentrates upon measures that can be adopted in the UK. However, the amount of food that is imported, and the quality of that food, will have an impact

upon the target. This will be considered in the light of a report currently being prepared for the Agency Board on food imports and the possibility of supplementing this strategy with special measures addressing the microbiological quality of imported foods will be considered.

Annex A

Main organisms causing foodborne disease

Campylobacter

This is the commonest bacterial pathogen isolated from people with diarrhoea. Isolations from humans increase in the late spring, most often as sporadic cases. The organism is spread via food (undercooked or via cross contamination), water or from animals but it does not normally grow in foods. Sources of contamination have been poultry meat, red meat, unpasteurised milk, untreated water, shellfish and contact with domestic animals. The symptoms of infection include general malaise, followed by severe diarrhoea and abdominal pain. Blood and mucus may be excreted in stools. Vomiting is rare. There may be complications such as reactive arthritis and Guillan-Barré syndrome, a neurological condition resulting in paralysis. The incubation period is 1-10 days and the duration of illness 2 days - 1 week.

Group A rotavirus

Rotavirus is a very common cause of severe diarrhoea among children. The primary mode of transmission is faecal-oral but because the virus is stable in the environment, transmission can occasionally occur through ingestion of contaminated water or food and contact with contaminated surfaces. In countries with a temperate climate, the disease has a winter seasonal peak. The disease is characterised by vomiting and watery diarrhoea for 3 - 8 days, and fever and abdominal pain occur frequently. Immunity after infection is incomplete, but repeat infections tend to be less severe than the original infection. The incubation period for rotavirus disease is approximately 2 days.

Norwalk-like viruses (NLV)

Norwalk-like viruses (NLVs) – until recently, known as small round structured viruses (NLVs) - are predominantly spread directly from person to person via the faecal-oral route or by aerosolised droplets produced as a result of vomiting. Infection can also arise from consumption of food contaminated by infected food-handlers or by

consumption of bivalve molluscs which concentrate viral particles from the water in which they grow. Infection causes an acute, self-limiting gastroenteritis characterised by nausea, vomiting, fever, diarrhoea, and abdominal pain, lasting 24 to 48 hours. Infectivity lasts for 48 hours after resolution of symptoms. The infectious dose for these viruses is extremely low.

Enteroaggregative *E. coli*

This is one of seven major groups of enterovirulent *E. coli*. They have been associated with diarrhoea in infants and travellers. The major routes of transmission have not yet been established. Symptoms include watery or bloody diarrhoea and abdominal cramps, with or without fever and with little or no vomiting. Enteroaggregative *E. coli* can also cause chronic diarrhoea.

Salmonella

Salmonella is one of the most commonly reported agents of foodborne infection. Common food vehicles include unpasteurised milk, raw egg products, meat and poultry. Foodborne spread can be due to inadequate cooking and cross contamination, and the risk of infection can be increased by poor handling/storage techniques because the organism is able to grow in food. Other routes of transmission include direct contact with infected animals, including pets, and person to person spread. Symptoms include general malaise, diarrhoea, fever, vomiting and severe abdominal pain. The incubation period is usually 12-48 hours, but occasionally can be up to 4 days, and the duration of illness can be up to three weeks. People may continue to carry the organism for up to 12 weeks or longer after the symptoms have subsided. Normally, relatively large numbers of bacteria are required to cause illness in healthy adults but vulnerable groups (the very young, the elderly and immuno-compromised) can be infected by lower numbers. In some cases infection can occur from very low doses, particularly in foods with a high fat content that protect salmonellae from the acidity of the stomach.

Clostridium perfringens

These bacteria produce spores that survive normal cooking. The cooking process may stimulate germination of the spores and multiplication can then occur if subsequent

temperature control and/or reheating is inadequate. Sources of infection have included contaminated bulk cooked meat and poultry dishes that have been left at ambient temperature during cooling and storage. Ingestion of large numbers of vegetative cells results in sporulation and associated enterotoxin production in the small intestine. The symptoms of *C. perfringens* poisoning include diarrhoea and acute abdominal pain. Vomiting is uncommon. Complications and death are rare and usually occur only in elderly/debilitated people. The incubation period is 8-18 hours and the duration of illness is usually less than 48 hours.