BACTERIAL FOOD POISONING

- *Trends in the various bacteria*
- *Root causes*
- *Possible responses*

POST note 101 July 1997

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Food safety has been an increasing focus of parliamentary and public debate in recent months, prompted by the report by the Pennington Group on *E. coli* O157, as well as by concerns over rising levels of food poisoning in general, standards of hygiene in abattoirs, etc. Such events have taken place against the backdrop of debate over the Food Standards Agency (FSA) and its remit.

POST is preparing a report on bacterial food poisoning, the underlying causes and the research and regulatory issues that arise. This will be available in October 1997, but this interim briefing highlights some of the key trends and questions raised.

OVERALL TRENDS

Public concern over the safety of food has been heightened by food poisoning outbreaks such as that due to *E.coli* O157 in Scotland. But how far are such concerns a reflection of a few isolated incidents rather than the underlying trends? To answer this question, one can turn to three main sets of statistics:

- notifications[1] from doctors ('formal') and other sources ('otherwise ascertained');
- results of laboratory tests;
- investigations by UK Surveillance Centres[2] into 'general outbreaks' of infectious intestinal disease (IID), which account for ~10% of all cases.

Recent trends in notifications are shown in **Figure 1** and reveal significant rises in all regions. In England and Wales, total notifications have risen more than fivefold between 1982 and 1996, from just over 14,000 to more than 83,000. Figures for Scotland have risen from around 2,700 in 1980 to over 10,000 in 1996, and a similar upward trend is seen in Northern Ireland, with notifications rising from ~100 in 1980 to ~1,000 in 1994. When population changes are taken into account (**Figure 2**), it is clear that there are major geographical variations, with Northern Ireland showing much lower rates than either England and Wales or Scotland.

Figure 1 UK NOTIFICATIONS OF FOOD POISONING

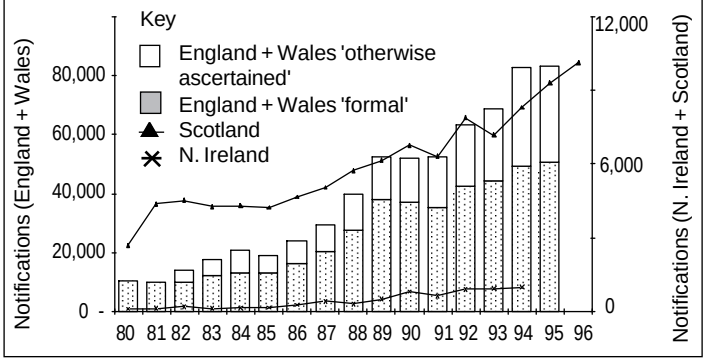
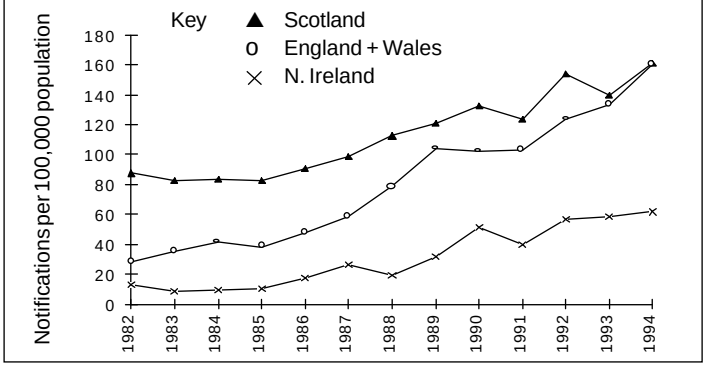


Figure 2 NOTIFICATIONS ADJUSTED FOR POPULATION



TRENDS IN SPECIFIC BACTERIA

Most species of bacteria are relatively harmless or even beneficial to man, and only a relatively small number cause illness if they are present in the food we eat. The most important of these are listed in **Box 1,** together with the number of cells needed to cause illness (from as few as 10 with VTEC[3], to as many as millions for *Cl. perfringens, S. aureus*), where they come from and the foods they are most commonly associated with, as well as the illnesses they cause. CDSC data (from diagnostic laboratories throughout the country, and from investigations of outbreaks) suggest that *Campylobacter*, *Salmonella* and *E.coli* O157 are the main organisms of concern, and recent trends in the number of laboratory positive results are shown in **Figure 3**.

Campylobacter - is now the commonest bacterium detected by diagnostic laboratories, with cases rising throughout the 1980s and peaking at just under 50,000 each year in 1994. Fortunately the vast majority of cases are relatively mild, with only ~1% requiring medical intervention. Rates of infection in Scotland, England and Wales are similar (~80-90 reports per 100,000 population) but much higher than in Northern Ireland (~25 cases per 100,000). The vast majority of *Campylobacter*

1. To the Office for National Statistics (ONS) in England and Wales, the Scottish Centre for Infection and Environmental Health (SCIEH) and the Department of Health and Social Services in Northern Ireland (DHSSNI).

2. The Public Health Laboratory Service's (PHLS) Communicable Disease Surveillance Centre (CDSC) in E&W, SCIEH, and DHSSNI.

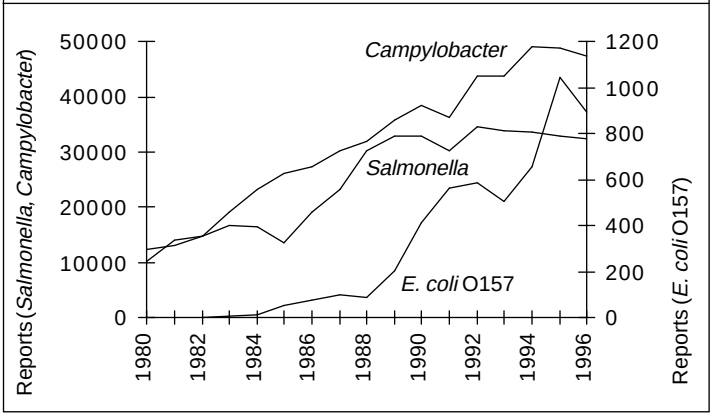
3. VTEC is Verocytotoxin producing *E. coli*, of which *E. coli* O157 is the commonest type associated with food poisoning.

infections are isolated cases rather than part of outbreaks, probably reflecting the fact that *Campylobacter* is one of the few food poisoning bacteria that does not normally grow in food at room temperatures.

Salmonella cases grew steadily during the 1980s, peaking at over 35,000 per year in 1992, but declining slightly since (Figure 3). Rates were again higher in England, Wales and Scotland (~60 per 100,000 population) than in Northern Ireland (10-12 per 100,000). More than 2,000 different 'sub-types' of *Salmonella* are known, but one of these is responsible for much of the increase in human infections (*S. enteriditis* phage type 4 (SePT4)), which rose from less than 1,000 to nearly 18,000 cases from 1982-1992. This trend mirrors trends in infections among farm animals (particularly in poultry where control measures taken led to the slaughter of nearly 400 flocks or over 2 million birds infected with this bacterium between March 1989 and February 1993). More recent concerns have focused on the emergence of another subtype - *S. typhimurium* DT104 (StDT104) - in both animals (StDT104 is now the most common *Salmonella* found in cattle) and humans (where infections have risen from around 800 reports in 1992 to ~4,000 in 1996). In addition to causing food poisoning this subtype carries resistance to a wide range of commonly used antibiotics. Overall, Salmonella accounts for about **half of all general outbreaks** of food poisoning, with poultry, eggs, red meat and meat products being among the most commonly implicated foods.

***E. coli* O157** was virtually unknown prior to the 1980s, so testing for it only began in 1982 (in England and Wales). Since then, overall UK rates have risen considerably, peaking at over 1,000 cases in 1995 (Figure 3). Although it affects considerably fewer people each year than either *Campylobacter* or *Salmonella*, the serious nature of the illness it causes and the low numbers of bacteria required to cause disease (Box 1) make *E. coli* O157 a serious threat to public health. Large geographical variations in reporting rates between different parts of the UK are apparent, with Scotland showing the highest rate (4-5 cases per 100,000 population), followed by England and Wales (~1) and then Northern Ireland (~0.2). The disproportionately high rate in Scotland also features in the outbreak figures - of the 39 British outbreaks of *E. coli* O157 food poisoning between 1987 and 1994, 16 occurred in Scotland. Most recently, the 1996 outbreak in Central Scotland[4] affected 496 people, 20 of whom have died - the largest total of deaths associated with any such outbreak worldwide.

Figure 3 LABORATORY REPORTS OF *Campylobacter, Salmonella* and *E. coli* O157 (UK, 1980-1996)



Other bacteria - Cases of listeriosis (caused by *Listeria monocytogenes*) suddenly rose during the mid-1980s, peaking at around 300 cases in 1988, but fell back to their earlier levels after action was taken over levels in imported pates and cheeses. No recent trends are discernible in the number of cases caused by other 'classic' food poisoning bacteria such as *Cl.perfringens*, *S. aureus* or *B. cereus*. Finally, there have been no cases of botulism (caused by *Cl. botulinum*) in the UK since 1989, when an outbreak affecting 27 people (1 of whom died) was traced back to a contaminated batch of hazlenut puree.

The overall picture is thus of a large rise in the total number of notifications of food poisoning, which now affect almost 100,000 people annually, hospitalising

4. This outbreak consisted of several separate but related incidents, including a lunch in a Church Hall, a birthday party in a Public House, and retail sales in Lanarkshire and Forth Valley. The link between these is thought to have been meat products from a local Wishaw butcher.

Table 1 FOOD POISONING BACTERIA

Species	*Infective dose (cells/g)*	*Source/reservoir*	*Typical foods*	*Symptoms (incubation time)*
B. cereus	~100,000	Soil, dust, sediments	Cooked rice, meat, vegetables	Vomiting, nausea, diarrhoea (1-16h)
B. subtilis	~100,000	Soil, dust, vegetation	Cereal + dairy products	Vomiting, diarrhoea (1-14h)
Campylobacter	~100	Farm animals, pets, man	Poultry, raw milk	Diarrhoea, fever, abdominal pain (2-5h)
Cl. botulinum	Toxin is lethal in very low doses	Soil, mammals, birds, fish	Fish, meat, home-preserved vegetables	Double vision, dry mouth, respiratory difficulties (1-3 days)
Cl. perfringens	~1,000,000	Soil, animals, man	Cooked meat, poultry, gravy	Diarrhoea, abdominal pain (8-18h)
E. coli (VTEC)	Very high infectivity (e.g. 10s of cells)	Cattle, sheep	Undercooked meat, raw milk, cheese	Bloody diarrhoea, kidney and neurological complications (1-6days)
Listeria	Relatively low infectivity	Wide environmental distribution	Cheese, raw milk, coleslaw	Mild flu, meningitis, (1-10wks)
Salmonella	Risk varies	Animals, man	Meat, poultry, eggs, dairy produce, chocolate	Diarrhoea, fever, abdominal pain (12-24h)
Staph aureus	100,000-1,000,000	Man	Ham, poultry/egg products, cream, cheese	Vomiting, diarrhoea (2-6 h)
Yersinia	Relatively low infectivity	Water, domestic + wild animals	Milk, pork, poultry	Watery diarrhoea, abdominal pain, fever (3-7 days)

several hundred and killing some. *Campylobacter* has replaced *Salmonella* as the predominant bacterium involved, and new threats are emerging in the form of VTEC and novel *Salmonella* sub-types (SePT4, StDT104).

ISSUES

What is actually Happening?

Key scientific issues underpinning the current debate will be explored in detail in October's POST report. One fundamental question is how real are the increases revealed in Figure 1 - particularly since large numbers of cases of food poisoning go un-recorded, and thus changes in the reporting rate (e.g. by an increased willingness to go to the doctor for an upset stomach) could account for at least some of the apparent increase. When the detailed trends are examined however, there are few grounds for dismissing them as due to anything other than a real increase.

Why should this happen in an age where food production, processing, handling, retailing and sale outlets are more regulated than before, and there is no shortage of technology in the food chain? There is no simple, single answer to this but, against a complex background, some trends appear more important than others.

First, some increasing trends do seem to be linked to changes in the **agricultural 'reservoir'**. With *Salmonella*, upwards trends in specific sub-types isolated from humans have coincided with similar trends in the same sub-types among farm animals (e.g. SePT4 in poultry and StDT104 in cattle). The link between trends in human and farm animal infections with *E. coli* O157 or *Campylobacter* is less clear cut. With *E. coli* for instance, the sub-type most commonly found in humans (*E. coli* O157:H7) is also present in cattle, but there is no information on whether infection rates have increased or vary from one region to another (Scotland suffers the highest rates of *E.coli* O157 poisoning). *Campylobacter* is widespread in poultry and this is thought to be the source of around two thirds of human infections; more detailed information on the links between human and animal infections will require recently-developed typing methods to be applied more widely.

Slaughterhouse/abattoir practice has been under constant scrutiny in recent years, and poor hygiene can allow infection in one animal to spread. Various enquiries have shown much room for improvement, and many measures have been introduced to improve standards. Research however suggests that the link between better hygiene in abattoirs and the microbiological quality of the meat produced is not straightforward - recent research suggests that the very best abattoirs achieve no more that a 50% reduction in bacterial count compared to the very worst (relatively insignificant in microbiological terms). Even the most comprehensively optimised hygiene practices achieve only a modest (~fivefold) reduction in count. On the other hand, meat from a faecally-soiled animal can have up to 1,000 times more bacteria than meat from a clean animal.

These findings underline the importance of taking a holistic view and of underpinning regulations with sound science. New EU regulations will have contributed to a reduction in the number of abattoirs from 1385 in 1975 to 384 in 1996, leading to substantial increases in the distance travelled from farm to abattoir, and associated stress and soiling of animals presented for slaughter. In the light of the research above, even small increases in the number of soiled animals could undermine or reverse any improvements in microbiological quality of meat resulting from the regulations.

Another possibility is that the rise in food poisoning is a function of the **complexity, scale and length of the modern food chain**. The trend towards sourcing raw materials from all over the world, of lengthening shelf lifes and distribution chains could all act to increase the potential for bacteria to be present and to grow. There is little direct evidence for or against this happening, although this could not account for the large increase in *Campylobacter* food poisoning in recent years (because this bacterium does not generally grow in food).

To try and determine trends in the **food, catering and retail sectors**, it would be useful to plot the changes in sources of food poisoning over the years. Unfortunately, the majority of cases are not attributed since detailed 'inquests' are largely restricted to general outbreaks. Nevertheless, some insight can be gained from these, even though they only account for around 1 in 10 cases of food poisoning. Recent figures show that 44% of outbreaks originate from the consumer buying meals from restaurants, hotels and other catering establishments. In contrast, domestic catering accounted for 17% of outbreaks and shops and retailers only 6%. These statistics thus suggest that **eating out remains a very important source of food poisoning and may dwarf that originating from shops and retailers** which are the current focus of concern following the *E.coli* outbreaks. Another general lesson from the outbreaks data is that most were easily preventable, having arisen mainly from inappropriate storage, inadequate heating and cross-contamination.

Moving away from the provision of food, to the **consumers** themselves, the last 10-15 years have seen many changes which could have a bearing on food poisoning trends - more shop at supermarkets on a weekly (or less frequent) basis, relying increasingly on fridges and freezers to store food in the home; more people eat out; new products (e.g. chilled foods) or preparation techniques (e.g. microwaves) require stor-

age and preparation instructions to be closely followed; some consumers want more 'natural' foods with fewer chemical preservatives; demographic trends may mean that more food is being prepared by children, or one meal being 'stretched' over days.

With these trends, there are more combinations of foods and circumstances which can give rise to a risk of food poisoning. If anything therefore, consumers need to be more aware of the principles of food hygiene than in earlier years. There are few measures of whether consumers' standards of food hygiene have improved or worsened over recent years, but it is clear that consumers must shoulder some of the responsibility for recent trends. Despite highly publicised outbreaks giving the impression that the problems are largely confined to the food industry, the vast majority of cases of food poisoning still affect individuals or small family groups. The expert consensus is thus that **all those involved in the food chain (including consumers) have their part to play in minimising the risks.**

Reversing the Trends

The political momentum behind the Food Standards Agency is considerable, but there are already many changes underway or under consideration following recent enquiries (particularly from the Advisory Committe on the Microbiological Safety of Foods review of poultry meat and the Pennington Group review of the *E.coli* outbreak in Scotland). Priorities identified here include measures throughout the length of the food chain - from the 'farm to the fork'.

On the farm:
- An awareness programme on the existence, potential prevalence and nature of *E. coli* O157.
- The need for care in the use of untreated slurry and animal manure.
- Minimising contamination in feed and improved hygiene in production systems.

In the slaughterhouse:
- Clean animals / birds.
- Reduce scope for cross-contamination by better tools and machinery and training.
- Consideration of end-process treatments such as steam pasteurisation to kill bacteria.
- Better implementation of Hazard Analysis of Critical Control Points (HACCP).

Food processing, distribution and retail:
The main approach here is through better implementation of HACCP, which the Pennington Review showed to be patchily applied - particularly in smaller outlets. In the longer term, HACCP might be applied more generally through regulations and the underlying EU Directives. In the meantime, interim measures are under consideration to help tighten existing legislation - firstly, to clarify the position regarding which premises are intended to be covered by the Meat Products (Hygiene) Regulations 1994. Secondly, that selective licensing arrangements should be introduced for premises not covered by the clarified 1994 regulations.

On this last point, one current issue concerns the separation of cooked and raw meats in butchers shops, where complete physical separation (using different preparation areas, utensils, staff, etc.) could be very difficult and expensive to apply in smaller businesses, threatening their viability in some cases. The Government is consulting on how to strike a balance between the Pennington Group's original proposals and their economic and social impact (which according to a survey by the Meat and Livestock Commission could be as much as £187M in capital costs and £160M per annum in revenue costs in Great Britain).

Consumer issues:
While consumer surveys show that on the whole, consumers are aware of the main principles of food hygiene, they don't always put them into practice - moreover, as discussed above, factors such as the emergence of *E. coli* O157, increasing complexity of food technology, demands for ever longer shelf-lifes, etc., demand high standards of hygiene from consumers, and more complex educational campaigns. In this context, general educational campaigns are likely to be of continuing importance (e.g. MAFF's Food Sense campaign and the annual National Food Safety Week), but there is continued debate over whether food hygiene education in schools is too dispersed (e.g. in science) and should have a single focus (as used to be the case within Home Economics).

Research Issues

Science and technology may have a major role to play in future. For a start, the lack of data on what is really going on leads to interest in investigating where infections are coming from and how they are transmitted through the food chain. There is also the prospect of trying to anticipate trends rather than merely react to the latest scare. Technology may have something to offer in avoiding problems in the home - whether through intelligent packaging (which senses when it has not been safely stored) to antibiotic surface coatings. Other possible 'technical fixes' could include interventions to reduce infections in animals (vaccines, competitive excluders, etc.) and contamination in carcasses (e.g. irradiation, steam pasteurisation). Such questions will be explored further in the full report, along with scientific considerations relevant to the debate over the Food Standards Agency.