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FOOD BORNE ZOONOSES

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Farm animals are distinct from animals kept as companions, or employed in other social roles, such as guide or hearing dogs. By their very nature they are kept to provide revenue for the farmer, from the sale of products, the majority of which are consumed as food.

Because of this role the diseases that are transferred to humans, following the consumption of this produce are significant. These diseases are described as 'Food borne zoonoses'.

Definition

Food borne zoonoses are defined as "Those diseases contracted from eating foods of animal origin'. This definition is sufficiently wide as to cover the wide spectrum of pathogens, including prions. The most important however are still the traditional culprits, responsible for the majority of food poisoning cases, bacteria. Of particular significance are *Campylobacter, E. Coli, Listeria* and *Salmonella spp.*

Food borne zoonoses and Society

The systems used in the agricultural industry are important in reducing the societal impact of these diseases. When the systems work efficiently, they prevent the transmission of disease into the food chain. The prevention measures necessary are not solely for producers, they also spread throughout foods transit from farm to table, and have to be applied rigorously at every stage. The system carries with it considerable monetary costs, and an inspection and enforcement burden for both local and national enforcement bodies.

When the system fails, for whatever reason, the effects on health can be profound with serious illness or death as outcomes. The producer, transporter,

and retailer are not the only fallible links in the chain, people often fall ill because they abuse the food they eat by an inability to store, handle or cook food correctly.

Infective pathway

An animal contaminated with a pathogen, which may or may not produce clinical signs of disease in the animal, produces a food item, such as milk, or meat following slaughter. The pathogen is transferred to the product, which is then consumed without adequate cooking or other processing and disease results.

Foodborne Zoonoses associated with meat

Most people in the United Kingdom still eat meat or meat products. There are several significant foodborne zoonotic pathogens associated specifically with meat. These now include the prion protein associated with variant Creuzfeldt Jakob Disease (vCJD). The following sections describe the most significant pathogens.

Escherichia coli

Escherichia coli is a normal part of most mammals gut flora. It has several distinct serotypes of which *E.coli* 0157:H7 is the most famous and dangerous. This serotype is variously known as EHEC (Entero Haemorrhagic *Escherichia coli*), Shiga Toxin producing *E.coli* (STEC), or VTEC (Vero cytotoxin producing *Escherichia coli*) 0157. The organism carried in animal faecal material contaminates foodstuffs which are then consumed, or is transferred by direct contact. The organism is particularly associated with ruminant animals, especially cattle, sheep and goats (Tarr, 2005).

Most cases occur in children, the elderly, or the immunocompromised. An outbreak stenned from J M Barr & Son, butcher and baker of Wishaw, Scotland in December 1996. The outbreak is believed to have followed cross contamination between cooked and raw meat. The outbreak was serious and extensive. There were 272 confirmed cases of which 60 were classified as probable, and 164 as possibly linked. 127 people were admitted to hospital, 13 required dialysis, and 18 died. Three further patients died later from complications associated with infection giving a final figure of 21 fatalities for the outbreak. Of the dead, 8 had attended the Wishaw Church luncheon, and 6 were residents of Bankview Nursing Home to which cooked meats from J M Barr had been supplied. The 18 people who died during the outbreak were all over 69 years of age.

previously prepared gravy, which had been incorrectly stored and inadequately reheated (MMWR Report, 1994).

Botulism

Botulism as a complex of disease states arises from contact with *Clostridium botulinum* or its associated neurotoxin. As with other species of *Clostridia* it forms spores which can survive desiccation and heat. It is often associated with ducks, geese and some other types of poultry. Cattle and horses have also been found to act as hosts for some strains. The organism is found in the environment, and also in the gastro-intestinal tract of infected mammals, that may be asymptomatic carriers and amplifiers, although certain strains can affect them as well.

Foodborne botulism is not infective; it is related solely to the ingestion of botulinum toxin, it is normally associated with products such as duck pate, sausages, and seafood, including smoked fish which have been inadequately heat treated, as the neurotoxin is destroyed at high temperatures. The amount of toxin necessary to cause clinical signs is measured in nanograms, thus although foods ingested may contain no active bacteria the residual toxin content can be sufficient to produce symptoms (Sobel *et al*., 2004).

The disease usually begins 18 to 36 hours after the ingestion of the toxin, early signs include gait difficulties, dysphagia, and impaired vision. Respiratory distress, muscle weakness, with abdominal distension and constipation may appear progressively. In severe cases assistance to maintain breathing by mechanical ventilation is required to prevent death. Botulinum antitoxin is used to treat the condition, and provided respiratory support is maintained, the majority of cases will make a full recovery. The antitoxin may be obtained from locally designated centres throughout the UK, and in emergencies through the Department of Health Duty Officer on telephone number +44 (0)20 7210 3000. There are cautions related to its use, as hypersensitivity reactions are not uncommon. Therapy should only commence after specialist advice has been obtained (Cherrington, 1995).

Many cases of foodborne botulism are believed to go undiagnosed, as the symptoms may be transient, with confusion of clinical signs with Guillain-Barre syndrome.

Yersinia enterocolitica

Of the same bacterial genus as plague, it is transmitted to humans by ingestion of foods as diverse as meat (pork, beef, and lamb), oysters, fish and raw milk. It causes an acute onset gastro enteritis with diarrhoea and vomiting, marked fever and abdominal pain. The pain can be so severe that it mimics appendicitis and

has also led to misdiagnosis of Crohns disease. It has the capability to produce clinical complications that include septic arthritis, colonisation of existing wounds, bacteraemia and urinary tract infections. Luckily it is rarely fatal.

Cryptosporidiosis

The *Cryptosporidia*, a family of spore forming parasitic protozoans, are found widely in the environment, and can be found in a wide variety of foodstuffs, with contamination arising from animal faecal matter. *Cryptosporidium parvum* is considered to be a particularly significant pathogen. Calves, lambs, and deer have been identified as asymptomatic animal reservoirs, capable of shedding viable organisms in their faeces. (Dillingham *et al*., 2002)

Human infection follows either direct contact with animal faeces, or consumption of inadequately cleaned or cooked products. There have also been incidents of individuals contracting the disease after swimming in contaminated water. Person to person spread has also been recorded, and is a particular risk in care settings.

An inoculum of less than 100 encysted organisms can cause clinical disease. Following a pre-patent period of between two to fourteen days, and in individuals with no underlying risk factors, there is profuse self limiting watery diarrhoea, with abdominal pain and cramps, and a low fever that may last up to seven days. Loss of appetite and anorexia can follow with severe weight loss, especially in immunocompromised patients. There is also a high probability of relapse, with many patients having another bout of diarrhoea within 14 days of apparent cure.

In patients with HIV/AIDS, the disease may progress chronically, spreading to the bile duct, Central Nervous System and lungs. Unless treated swiftly, death will follow.

In low risk patients' treatment is purely supportive. Severe cases may need intensive care, however treatment is difficult, and as yet there is no specific therapy for this pathogen. The strategy employed in HIV/AIDS patients centres around boosting the already damaged immune system with optimal retroviral therapy.

The pathogen can be destroyed by freezing, drying, or heating materials to greater than 65°C, and irradiation. It is resistant to many disinfectants in common use.

Campylobacter spp.

Campylobacter is a much under rated cause of food poisoning. The pattern of infection in the United Kingdom is very different to the United States for this pathogen In the UK, 80% of clinical cases are linked to contaminated food,

whereas in the USA most cases are waterborne, although there have been clusters of cases associated with the consumption of unpasteurised milk.

This particular pathogen is widespread, and present in many farm animals, with poultry in particular being very susceptible to carrying a heavy bacterial load. Under normal circumstances, the animals show no sign of disease, although there have been cases of abortion in sheep being linked to *Campylobacter jejeuni*. The bacterium has been isolated from pigs, birds, cattle, dogs, cats, unpasteurised milk, and water supplies. The two species considered significant in human disease are *Campylobacter jejeuni*, and *C. coli,* with the infective dose considered to be less than 100 viable organisms (Allos, 2001).

The organism is capable of surviving freezing and has been shown to survive for several months in frozen minced meat and poultry and also certain chilled foods, and thus cross contamination could be a factor in infectious spread.

The most immediate symptom of *Campylobacter* infection is a self-limiting diarrhoea of 2–10 days duration sometimes with bloody stools. *Campylobacter* mainly affects babies and young children, the immunocompromised, and the debilitated. Other symptoms include fever, nausea and abdominal cramps that may vary from mild to severe with occasional misdiagnosis as appendicitis as with *Yersinia enterocolitica*. Symptoms may regress and reappear over a period of weeks. A septicaemic form has been seen in HIV/AIDS patients. Clinical cases of *Campylobacter* are associated with 20–40% of cases of Guillain-Barré syndrome. The triggering of reactive arthritis has also been associated with the disease. Following infection it is estimated that less than 1% of the population may become asymptomatic carriers (Lee & Mijch, 1998).

In 2008, 49,883 cases of *Campylobacter* infection were reported in England and Wales to the HPA, a marked increase over previous years. During the Infectious Intestinal Disease (IID) study in England during 1993 to 1996 it was estimated that there were 870 cases per 100 000 head of population annually, with only one in eight cases being reported, which has been confirmed in other epidemiological studies. Extrapolation of these figures would give a total of 400,000 cases in 2008, making this a very significant pathogen.

In most cases the disease is controlled without resort to antibiotics, however as it may be life threatening in immunocompromised patients, antibiotics may have to be used. *Campylobacter* displays high levels of resistance to fluoroquinolones so any of the macrolide antibiotics are preferable, however there are now some isolates dually resistant to both antimicrobial groups. In acute cases where resistance is suspected, tetracyclines, chloramphenicol and gentamicin have all been used, however this is usually only initiated in secondary care settings after sensitivity testing has occurred.

The main control measure, is the reduction of faecal contamination of carcass at and after slaughter. Hazard Analysis and Critical Control Points HACCP

The BSE Inquiry

The United Kingdom government set up the BSE Inquiry in December 1997. The inquiry found standards of care and support for families varied widely and suggested that improvements were needed, including speedy diagnosis with informed, sympathetic advice to relatives about the future course of the disease and the needs of the patient. It is now recognised that there is a requirement for rapid assistance for families to allow victims to be cared for in their own homes, and access to hospice or similar care settings in the final phases of the diseases progress (BSE Inquiry, 2000).

Much of the health professional input in the care of victims of vCJD is palliative and relies heavily on good nursing practice. It has been found that many staff have become distressed and shocked whilst carrying out their duties in support of patients and their relatives, due to the nature and rapidity of the disease progress.

Epidemiological Clusters

Through the work of the CJDSU, two clusters of cases have been identified. A cluster of cases of vCJD was first identified in the Leicestershire village of Queniborough in November 1998. Between August 1996 and January 1999, 5 people developed the disease and subsequently died. All the victims lived in the area between 1980 and 1991, and therefore the investigation concentrated on this period, as this was the only time period when a common exposure could have occurred.

An investigation was also undertaken into 3 deaths, in Armthorpe, near Doncaster. Two of the victims came from the same street, and the third visited the area frequently.

The expert findings into these 2 clusters excluded a number of factors that linked the victims including surgery and blood transfusions, dental surgery, occupational exposure, immunisations, injections, body piercing, cuts and animal bites, baby foods, school meals, drinking water and high manganese levels. All of these factors had been postulated as causing or contributing to the development of vCJD, however the links were unproven.

In each cluster the source appears to have been contaminated beef from cattle with BSE derived from animals which were Friesian-Hereford crosses born of dairy cattle and fattened on for slaughter. Such animals are slow to fatten and were therefore slaughtered at 30–36 months of age, rather than at the younger age normally associated with beef breeds. Being older, and given their feeding pattern, it was more likely that these animals could have had subclinical BSE at slaughter. This was compounded by slaughtering practice in local abattoirs. Cattle were slaughtered using a captive bolt as usual; however, in some local abattoirs and butchers, a pithing rod was also used to prevent the beast kicking after

slaughter. The use of a pithing rod ruptures the brain structure and is more likely to release infective material into the work area, or onto the carcass, especially as the prion is most concentrated in brain material. Some local butchers also removed the brain from the head of the beast for further processing, increasing the chance of contaminating the meat.

Small abattoirs also often used a cloth to wipe down the beast after slaughter to remove any unwanted tissue, rather than hosing the carcass down as was usual practice in larger slaughterhouses. This practice increased the likelihood of contaminating the meat with infective material. At the time there was no legislation to define best practice.

The initial work of the inquiry team found that there was an association between the vCJD cases and the consumption of beef purchased from butchers where meat could have been contaminated with bovine brain. All the possible sources of meat were investigated to try and identify the butchery and slaughter methods used. The result showed that the victims were 15 times more likely to have purchased and consumed beef from a butcher who removed the brain from a beast compared with control groups who purchased meat from outlets where cross-contamination with brain material was not a risk.

The careful and exhaustive investigation of these clusters identified the likely timeframe for infection and has allowed the incubation period in humans of vCJD to be estimated as within the range of 10–16 years from infection.

Prevention of the vCJD and BSE

The prevention of the passage of vCJD from sufferers to other humans is addressed in several ways. Regulations have been introduced covering the use of bovine materials in medicines and vaccines. The law came into effect on 1 March 2001 for human medicines, and from 1 June 2001 for veterinary medicines. All manufacturers of licensed medicinal products are affected and the MCA and VMD ensure compliance.

Classic CJD has occurred by the transplantation of brain tissue or the use of brain derived extracts. As a result, surgeons, especially neurosurgeons who treat CJD patients are advised to destroy all surgical instruments after use (Garske *et al.*, 2006).

Blood and blood products have been identified as carrying a particular risk of transmitting vCJD, with four cases being reported by the HPA to date (Llewelyn *et al.*, 2004). Measures have been taken to treat blood used in the UK by leukodepletion to reduce any transmission risk. Fresh frozen human plasma has been imported to produce certain blood products from countries where BSE/vCJD is unknown (Turner, 2000).

Prevention Strategies

Prevention of a recurrence of the BSE/vCJD outbreak is of paramount importance to the government of the UK, and its subordinate departments. As a result there are a series of measures in place to reduce the risks of BSE-infected meat entering the human food chain.

Primary prevention focuses on preventing a resurgence of BSE in the UK cattle herd, and the presence of the disease in cattle at slaughter. Additional precautions are aimed at implementing and ensuring good butchery practice.

Any cattle suspected of having BSE are compulsorily slaughtered, and their bodies destroyed. Milk produced by cows which are suspected of having BSE may not be used for any purpose other than feeding the cow's own calf. In addition to this very obvious measure there are several other measures in place to protect animal, and by implication, human health. All cattle reared for beef destined for human consumption are ideally to be slaughtered at an age of less than 30 months. The requirement for removing the bones from meat before retail sale has now been lifted.

The Over Thirty Months Slaughter (OTMS) scheme banned the sale of meat derived from cattle aged over 30 months at the point of slaughter for human consumption and was introduced by SEAC in 1996. On 7 November 2005, following extensive consultation and risk assessments, a system of BSE testing was introduced for slaughtered cattle aged over 30 months (OTM) intended for human consumption. This system replaced the OTMS rule prohibiting the sale of beef for human consumption from OTM cattle.

It is still uncertain what the future will hold in terms of case numbers, however it is now seen as unlikely that there will be mass fatalities, although a few confirmed cases are expected annually (Ghani *et al.,* 2003).

Milk borne diseases

Brucellosis

Brucellosis was named after Bruce, who in 1887 identified the bacterium that caused "Malta dog", a disease familiar to many generations of seafarers. He named this pathogen which he isolated from goats milk, *Brucella melitensis.* This is only one of several species responsible for human infection which include *B. abortus* from cattle, *B. melitensis* from sheep and goats, *B. canis* from dogs, and *B. suis* from pigs. The diseases are distributed worldwide and are particularly prevalent in South America, Africa, The Mediterranean, Asia, and Eastern Europe where large flocks of animals are tended, and where eradication programmes are impracticable or unenforceable. The WHO has an ongoing

programme of eradication by slaughter and vaccination aimed at controlling the disease in countries around the Mediterranean basin (Godfroid *et al*., 2005).

The United Kingdom declared eradication in 1993 of *B. abortus*, and the use of pasteurisation, vaccination, and slaughter inspection has been successful so far in preventing recurrence. *B. melitensis* has never been isolated from animals in the United Kingdom and is therefore not considered to pose a threat.

In animals the main symptoms are focal necrosis of the placenta, abortion and future infertility. The birth fluids and afterbirth are highly infective and cattle grazing on contaminated pasture are infected by consuming contaminated material. The disease is inapparent before the heifer aborts. Bulls may also be infected and can sexually transmit the pathogen, until ultimately becoming sterile. Cattle may be infected with any of the zoonotic strains although horses appear to be resistant to all of the known zoonotic strains.

Diseases in man usually follow the ingestion of infected unpasteurised milk or milk. An alternative route for infection is by contact with contaminated bodily fluids, membranes or aborted young. There is some evidence for aerosol spread by infected droplets or dusts. Human disease presents with lymph node swelling, enlargement of the spleen, fever, testicular swelling, influenza like symptoms and lethargy, nausea, weight loss. Endocarditis or meningitis may follow sometimes with fatal results (Miguel *et al*., 2006).

There is also a chronic undulant form, which was often seen in cowmen and veterinary surgeons. Periodic bouts of high fever and other clinical symptoms, are interspersed with periods of remission. This can persist for years or decades.

Treatment relies on the use of antimicrobials usually in combination to prevent resistance. The BNF and the WHO recommend the use of doxycycline plus rifampicin, or streptomycin. Therapy needs to be prolonged with the WHO recommending six weeks as a minimum duration. Longer-term therapy may be required in the undulant form of the disease. Recently, the quinolones in combination with rifampicin have been trialled and demonstrated to be effective.

There is no vaccine available to prevent human brucellosis.

Suitable protective clothing will reduce the risk from occupational exposure. The use of disinfectants especially chlorinated, iodine, or ammonia based products can prevent environmental hazards. The mainstay of prevention however is eradication by animal vaccination, or slaughter programmes. On a personal basis, travellers to areas where the disease is endemic should be encouraged to avoid unpasteurised dairy products and undercooked meat.

Q-FEVER

Q fever, first described in Australia in the 1950"s, is a disease that stems from cattle, although it usually causes no symptoms in the host animal. It is caused by

marrow, therefore complete blood chemistry analyses and liver function tests should be routinely carried out before and during therapy (Garcia *et al.,* 2008).

Tapeworm infection is not common in the United Kingdom, due to a strict system of meat inspection, however this is not true of the rest of Western Europe. Germany and France report significant numbers of cases annually associated with the consumption of infected meat in national delicacies. In Non Muslim developing countries, there is a high incidence of the disease, causing more than a third of all cases of adult onset epilepsy. Due to the longevity of the parasite, immigrants from these countries could present with symptoms of the disease long after their arrival in the United Kingdom. In the United States there have been sufficient cases among migrant workers for the condition of cysticercocis to be routinely tested for in cases of epilepsy amongst this sociological group. The number of tourists travelling from Great Britain to areas of risk, such as South East Asia, the Indian Sub Continent, and Africa have increased dramatically in the past decade, therefore tapeworm infestation should be excluded in any diagnostic path relating to persistent abdominal symptoms, or seizures following such trips.

Suspect meat or meat products should be thoroughly cooked, and consumption of raw or under cooked meat from dubious sources avoided. Suspect carcasses or meat should be frozen for at least 3 weeks to kill any larvae. Viable eggs or embryos may also be present in water contaminated by faecal matter; therefore the usual precautions when drinking water of unknown quality should be applied.

UK Food Standards Agency (FSA), scope and mission

In the UK, the Food Standards Agency (http://www.food.gov.uk/) was established in response to the Pennington report. It is responsible for monitoring safety and standards of all food for human consumption, advising on diet and nutrition, and enforcing the law pertaining to food. It is also tasked with commissioning research into food safety. The FSA is directed by an executive board, appointed to act in the public interest, and is established so as not to represent particular sectors of industry or government. Its members come from a wide and varied background, and bring to their work a range of relevant skills and experience.

The stated aim of the agency is to "protect public health from risks which may arise in connection with the consumption of food, and otherwise to protect the interests of consumers in relation to food."

The Agency has initiated a campaign called from "farm to fork", aimed at making food less contaminated, and safer for the ultimate consumer. Initiatives have also been launched to educate the public on food safety, nutrition, diet, and clearer labelling.

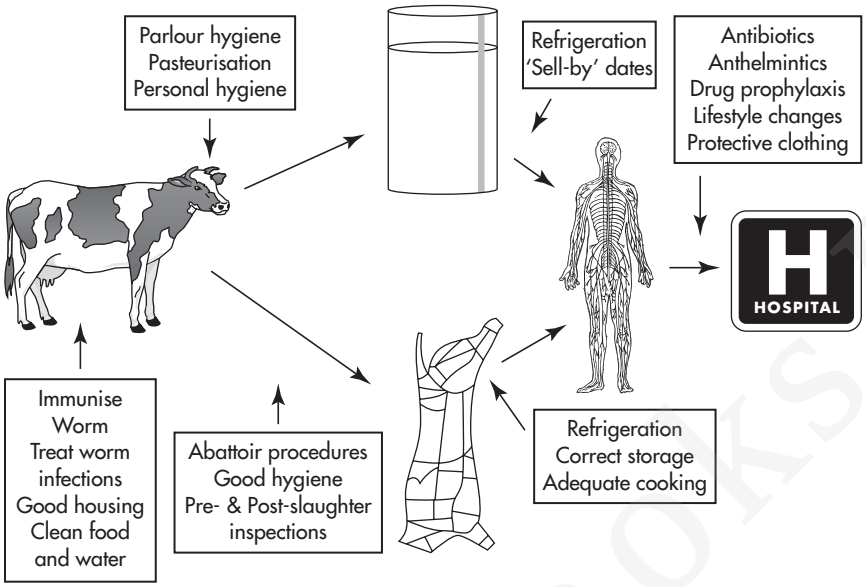

Figure 2.2 Prevention points and strategies for foodborne zoonoses.

The Agency is accountable to Parliament through the Minister of Health. As a safeguard for its independence it has the unique distinction of being given by statute the legal power to publish the advice it gives to the government. The Meat Hygiene Service is now accountable to the Food Standards Agency.

Reducing Zoonotic risks in Food

Reducing the risks of zoonotic disease from foodstuffs is not just a process that begins and ends with the final consumer. Legislation and other physical measures to reduce or exclude pathogens from food are applicable to every step of the food chain from field to table. Strategies for reducing food borne zoonoses are illustrated in Figure 2.2.

HACCP

One of the major food industry schemes for recognising and identifying risk, and its remedies, is the Hazard Analysis and Critical Control Points (HACCP) process. This is now internationally accepted as the preferred system for the management of food safety in food businesses. It has seven principles that provide a structured format for food safety by controlling hazards inherent in the food handling and production process.

HACCP applies to food producers, and also to retailing and catering premises through current legal measures. The Food Standards Agency has suggested that the principles should be extended to the agricultural process of food production, albeit in modified form. Currently, until this is adopted widely, the current system of recommendation of a stepwise approach to infection control will continue (Notermans *et al.*, 1995).

General stepwise prevention strategies

Knowledge of zoonotic infections is the key to producing an effective stepwise programme. The application of the understanding of the likely routes of infection, and the life cycle of the pathogen allows selective measures to be applied in a focussed way, so breaking the transmission route at its weakest point.

Some of these measures may not be familiar or fully comprehensible to health professionals, however they do form a non-medical system for prevention of disease, and are no less valid than more therapeutic orientated methods.

Step 1 Control the disease in the animal

The incidence of zoonotic disease in animals may be reduced by the use of vaccination, clean foodstuffs and water, good housing and husbandry. Overcrowded or insanitary conditions can often lead to overt disease or unthrifty animals, requiring more therapeutic support to maintain sufficient health for them to attain slaughter weight, or to continue to be productive. A reduction in infection rates has a dramatic effect on incidence of infection further down the food or product chain. The difficulties in implementing strategies at this point in the system are often economic, as although the measures may be available; there may be little or no economic benefit to using them. In some cases those costs can become offset by higher prices for produce, however that is not always the case. The lobby for animal welfare, and organic produce has improved the willingness of producers and consumers to pay more for their food if it is of better quality. The converse is that there is also a need for food at the lowest price, and a bulk producer for a large supply contract may need to cut corners to stay in business; increasing perceived, if not actual risks.

Step 2 Reduce contamination at harvesting

When eggs are picked out, or cows milked, the application of sensible hygiene precautions are essential. Eggs should be free of droppings, cleaned and date marked. In dairies, the udder of the cow, and the milking machinery should be as clean and hygienic as possible, with subsequent disinfection after each milking. Pipework and items such as clusters should be maintained and replaced as necessary to maintain adequate operating parameters. Milk should pass to the

bulk tank, and be subsequently chilled rapidly for later transport and pasteurisation.

At abattoirs, tight veterinary inspection both pre- and post- slaughter must be practised, with animals which display heavy faecal contamination being cleaned or rejected. Slaughterhouse controls should prevent or reduce onward transmission into the food chain, with rejection of suspect carcasses. Prompt refrigeration of meat and careful cleaning of the carcass, can reduce bacterial contamination drastically.

Step 3 Retailing controls

Disinfection of working tools and areas, alongwith personal and premises hygiene procedures, protect consumers and workers from zoonotic infection. Sourcing products from assured suppliers, temperature and environmental monitoring, and the separation of cooked and raw products reduce the possibility of amplification and transmission of infection. The tight control of "use by" and "sell by" dates is mandatory. Periodic inspection by Public Health Officials, and the implementation of monitoring of refrigeration and freezer plants is also essential.

Step 4 Domestic precautions

In the home consumers should use common sense measures, including disinfection of surfaces and equipment, personal hygiene procedures, and thorough appropriate cooking techniques. Using a refrigerator correctly and observing sell-by-dates would prevent many cases of food poisoning.

General food hygiene recommendations

The Food Standards Agency, the Food and Drinks Association and other public bodies have made various recommendations regarding food handling. These measures are designed to prevent cross contamination of raw and cooked foods, and also reduce the risk of consumers eating products that are raw or undercooked.

People should clean surfaces, equipment, and containers, which have come into contact with raw meat. They must wash their hands after handling raw meat and before handling other utensils. The same plate should not be used for cooked and raw meat, without washing the plate in between. Meat should be cooked until the juices run clear; especially burgers. Barbecues are considered to be particularly risky, as meat may be not be fully cooked, and if previously chilled or frozen, raw or under cooked in the middle.

These recommendations were made in the light of a number of surveys had shown that public awareness of food hygiene was lamentable.

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