FOODBORNE ILLNESS

Veterinary sources of foodborne illness

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Because microorganisms are widely distributed in animals and in foods of animal origin, control of foodborne infection is a formidable undertaking. The presence of many zoonotic diseases is often unsuspected or unrecognised in animals. On farms in the UK, especially the more intensively operated units, herd health schemes are run in cooperation with the veterinary practitioner and the State Veterinary Service where monitoring of disease is routinely carried out and active preventive medicine practised. Similar schemes are run in other developed countries. Factors which perpetuate problems include methods of husbandry (including the type of feedstuffs used), transport of live animals, and slaughter and meat processing practices (fig 1). Whichever system of farming is considered, it must be accepted that, however healthy our animals seem to be, pathogenic organisms are taken up from the environment, carried in the intestinal tract, and excreted in the faeces (fig 2). The aim, however, is to produce healthy animals, within the limits of humane rearing systems, with reasonable return on investment.

Animal enteric pathogens

The diseases of animals which affect the safety of food are predominantly those that cause enteric disorders. Soiling of the animal's coat with faeces will increase the possibility of subsequent contamination of food of animal origin. It is important that animals which produce milk or which will be slaughtered for food are kept as clean as possible.

Salmonella infection in animals produces an enteritis which affects the small and large intestines; many serovars, generally host-specific, have been identified. *Salmonella dublin* and *S typhimurium* are the most common serovars in ruminants. *S dublin* has a pronounced tendency to persist in cattle, which become intermittent or constant excretors or latent carriers; infection persists in the lymph nodes or tonsils, which can break down so that the animals become excretors under stress. *S dublin* is a more common cause of abortion in sheep than *S abortus ovis*. Disease due to *S typhimurium* is sporadic and likely to subside after initial exposure, only recurring if the source of infection reappears. This does not, of course, mean that the disease cannot persist in a flock or herd for long periods. In sheep and cattle at grass, clinical salmonellosis can appear when the animals are concentrated in small areas such as lambing pens, holding pens on the farm, or in auction markets, especially when associated with transport. The situation in goats is similar to that in other ruminant species. *S cholerae suis* infection in pigs has been especially well investigated following large outbreaks in UK pig units in the mid-1960s with high morbidity and mortality rates. Much of this infection was due to swill or garbage feeding which is no longer common practice. *S typhimurium* has also been found in pig units in which it presents as a necrotic enterocolitis, but in abattoir surveys, other serovars have been found in the mesenteric lymph nodes and caecal contents.[1]

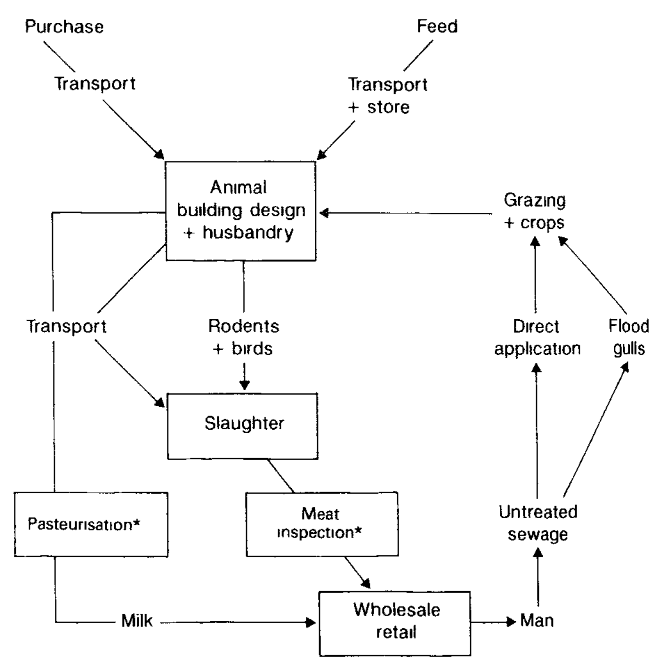

Fig 1—Veterinary aspects of control of foodborne illness.
*Control stage.

In poultry, salmonellae other than *S pullorum, S gallinarum, S enteritidis,* and *S typhimurium,* rarely cause clinical disease; the birds are symptom-free carriers. Clinical disease is seen in the young bird with substantial faecal excretion of organisms in recovered birds at time of slaughter as broilers—about seven weeks old.

Campylobacters can be isolated from the faeces of all animals, often without signs of clinical disease. In England and New Zealand, there is a seasonal prevalence of campylobacter infection in dairy cattle. There is some evidence of cross-infectivity between cattle and sheep of at least some strains.[2] *Campylobacter coli* and *C jejuni* have been implicated in enteritis, particularly in lambs in which morbidity rates have ranged from 20 to 75%, with mortality of about 3%. *C jejuni* causes abortion in sheep. Commonly,

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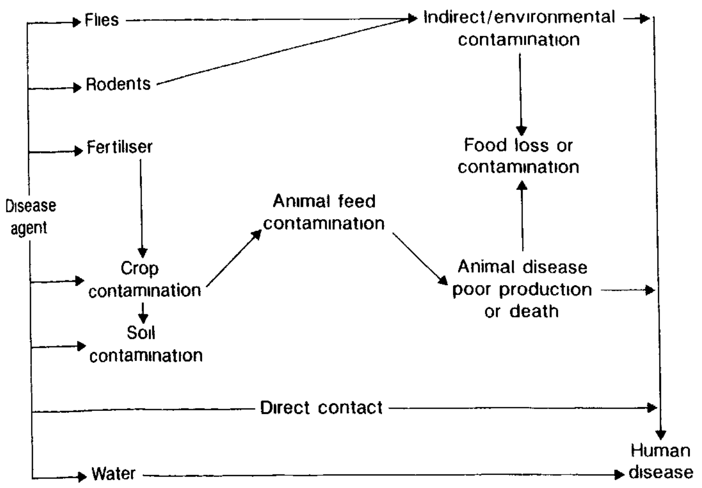

Fig 2—Sources of infection.

when campylobacters have been isolated from animals with diarrhoea, other pathogens (eg, *Cryptosporidium*, viruses, and other enteropathogenic bacteria) have been found.

Listeria species do not cause enteric disease but are found in the intestinal tract of animals and birds.[3] Herbivores probably ingest *Listeria* while eating grass, especially when it has been conserved in the form of silage; contamination is inevitable when machinery uplifts soil with the grass. There is a signigicantly higher prevalence of *L monocytogenes* in big-bale silage[4] because in this process more soil is taken up than in traditional forage harvesting for clamp fermentation. Since this product is more typically fed to sheep and goats, they are at greater risk of listerial infection. Septicaemic listeriosis, with or without meningitis, is most common in monogastric animals and young ruminants, whereas the meningeal cephalic form of the disease is more common in adult ruminants. In cattle, listeriosis tends to occur as single cases and sporadic abortions. Outbreaks in sheep and goats have been recorded soon after the start of silage feeding, with organisms subsequently being found in the faeces and milk.

All animal species are affected by *Escherichia coli*, the small intestine being the primary site of infection. The most important *E coli* are the enterotoxigenic K99 strains which typically cause a distinct acute illness, known as watery scour, in young calves and piglets. Although enteropathogenic and enteroinvasive *E coli* are also found in animals, the enterohaemorrhagic *E coli* (EHEC) are of particular zoonotic importance. EHEC O157:H7 (which is verocytotoxigenic) is increasingly recognised in human disease and may be foodborne, but other verocytotoxigenic *E coli* serotypes are more important in animals.[5] They produce diarrhoea in cattle and pigs (gut oedema disease). EHEC O157:H7 can certainly be found in the faeces of healthy cattle.

Yersinia spp are part of the normal gut flora of animals. *Y enterocolitica* can cause an acute enteritis with septicaemia and mesenteric lymphadenitis in sheep, goats, and pigs. *Y pseudotuberculosis* can lead to sporadic abortion in cattle and sheep and occasional cases of goat mastitis; it may produce enteric lesions and diarrhoea but more commonly causes multiple abscesses in the liver and the spleen.

Clostridium perfringens produces very acute disease with high mortality. Animal faeces are an important source of the organism, although the types of *Cl perfringens* associated with disease in animals rarely cause foodborne disease in man.

Cryptosporidium is an important enteric parasite in animals. This protozoan parasitises the gut of young livestock, which leads to severe diarrhoea and sometimes death. Some 30% of dairy herds in the UK are known to carry *Cryptosporidium*; from the age of about seven days, calves shed oocysts for about ten days but fewer than half of them have signs of disease unless other enteropathogens are involved. Subsequent re-infection of adults is possible from the young stock, with recrudescence after the stress of transport and lairaging (ie, animals kept at auction markets or abattoirs).

Giardia intestinalis is increasingly being found in the faeces of animals; little is known of its prevalence or of the disease it may cause in animals other than a chronic or intermittent diarrhoea, weight loss, and failure to thrive. *Giardia* has not been detected in pigs.[6]

Viral enteric diseases, especially those due to rotavirus and coronavirus, are important because they are responsible for a substantial number of neonatal diarrhoeas in animals, often with concurrent infections with Enterobacteriaciae.

Pathogens that affect the udder

Pathogens that affect the udder are important because they may get into the milk. Many infective agents have been implicated in mastitis. With the exception of tuberculosis, in which spread may be haematogenous, infection of the mammary gland is via the teat canal. Mastitis may be peracute or acute, with high mortality and morbidity; subacute, in which there is some change in the udder with clots and large numbers of leucocytes in the milk; chronic after an acute previous infection, with obvious changes to the udder and a variable extent of change in the milk; and subclinical, in which no change in the udder or milk can be seen.

Organisms which commonly cause mastitis in cattle and which are important with respect to foodborne illness include *Staphylococcus aureus* and *E coli*, with the latter becoming increasingly important in housed cattle. Other organisms relevant to foodborne illness that have been occasionally recorded as a cause of mastitis are *Salmonella*, *C jejuni*, and *L monocytogenes*. In the dairy cow, large numbers of *L monocytogenes* (25 000–30 000/ml) have been recorded in mastitic milk.[7] In surveys of raw milk from farm bulk tanks in north-east Scotland the incidence ranges from 2·8% of samples in the summer to 1% in October.[8] Lately, Wood and colleagues[9] described an *S enteritidis* infection involving a quarter of a cow's udder which continued to shed organisms into the milk; there was no faecal shedding of the organism during the seven months before slaughter.

Staph aureus is a common cause of mastitis in sheep and goats. Isolates from chronically infected goats have sometimes proved to be potentially enterotoxigenic and sheeps milk commonly contains toxin-producing *Staph aureus* (unpublished). *E coli* is increasingly found in mastitic milk; *Yersinia*, *Campylobacter*, and *Salmonella* are also occasionally found.

In addition to excretion of organisms in the milk, there is a risk during the milking process of contamination by faecal organisms. For example, *L monocytogenes* is regularly isolated from raw milk. Davidson and co-workers[10] found that 1·2% of samples from dairies and farms in Manitoba, Canada, were contaminated with *C jejuni* and 2·7% with *Y enterocolitica*. McEwen and colleagues[11] found that 4·7% of truckloads of bulk milk in Ontario, Canada were contaminated with salmonellae (13 serovars), with a contamination at farm level of about 2·8%.

Feed

Animal feed and water can be a major risk to the animal population if they contain pathogenic organisms or toxins. Irrespective of how carefully animal feed is prepared, there may be subsequent contamination by wild animals and birds during transport and feeding. Completely closed feeding systems with silos and conveyor belts in intensive units reduce this risk compared with free-range systems, which provide free access for birds and vermin. Water has also been identified as a source of pathogens for livestock, particularly campylobacters and *Cryptosporidium*.[12,13] In the UK, use of animal protein derived from ruminants in feed for cattle and other ruminants has been banned after the association of bovine spongiform encephalopathy with feed.

Mycotoxins are present in pre-harvest and post-harvest food, particularly cereals, intended for animals. Mycotoxins such as aflatoxin B_1 and M_1 may then pass into the milk. Specific controls have been introduced to monitor known sources such as groundnut and cotton seed cakes,[14] and maximum permitted levels for mycotoxins have been set.

Transport

The most severe stress for animals is associated with transport, especially when young calves (up to a week old) are transported and then exposed for sale in auction markets or taken to the abattoir as "bobby" (very young) calves. Stress of transport of poultry, which will increase the proportion of salmonella excretors, is reduced by the witholding of feed before transport. Correct transport in well-designed vehicles substantially reduces contamination of animals destined for slaughter; vehicles and crates should be cleaned and disinfected between loads. Movement of animals within and between countries brings additional problems of spread of disease. When diseases (important both to human and animal health) are present in the place of origin, animals must be put into quarantine or not introduced into a susceptible population of animals. Currently, harmonisation rules are being drawn up in the European Community so that there will be no compromise of the animal health status of any one member country.

Control

It must be accepted that food of animal origin is likely to contain organisms that are pathogenic for man, and continued efforts must be made to eradicate or reduce them to the minimum possible. Additionally, we must take into account that many organisms in the environment are pathogenic for the animals that we use for food. Although little can be done to remove these pathogens, it is possible to reduce further contamination of the environment by correct disposal of animal and human waste (fig 2). Irrespective of the type of farm or species of animal, a reasonable return on a farmer's financial investment will only result from the use of good methods of husbandry and the maintenance of a high standard of herd/flock health.[15] Disease or poor herd or flock performance in animals used for food is ultimately expensive for the farming industry. Therefore, it is in the industry's interest as well as in the interest of public health to produce healthy animals. There should also be effective liaison between human and veterinary surveillance organisations so that the presence of potential human pathogens in animals used for food and the occurrence of foodborne disease in man can be monitored.

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From The Lancet

Politics and pestilence

We pay dearly for our liberties, and for not having a paternal government. There is a great deal to be said for the opinion that stern and prompt action on the part of the Government five or six months ago might have extinguished the cattle plague. It was then so limited that it would have been possible to isolate it and all persons that had had any connexion with it. And if it be infectious, as nearly everybody who is entitled to have an opinion on the subject thinks it is, this would have prevented its extension, and made it purely local instead of a huge national calamity. But the doctrine of contagion is somehow or other unpopular. . . . Moreover, this doctrine of contagion is inconvenient. Locomotion is the order of the age, and undoubtedly it is uncommonly inconvenient to say or do anything that interferes in the slightest degree with the liberty of man or beast to go anywhere. . . . Why should [the Government] not appoint a commission to watch the other plague which we are all secretly dreading? Why should it remain in vague uncertainty (as bad as ignorance) of the most valuable information that must be procurable, if it was only somebody's business to procure it—of the use or uselessness of quarantine measures in the various places which have been visited with cholera or saved from the visitation—and of the efficiency or non-efficiency of the various remedies that have been administered? And why should not this be done at once? Surely the expense of such a course will not be seriously thought of when the possible advantages of it are considered. The Government cannot be complimented on the timeliness of its action in the matter of the cattle plague. Will it not atone for its fault by trying to avert a far greater evil, or at least taking steps that will put us in the best possible position for meeting it? Or will it repeat the folly of waiting till the mischief is done, and the judgment of the country is impaired by panic? No excuse can be valid for not imposing upon the best men that can be got the duty of ascertaining all that can be ascertained from the latest experience.

(Oct 14, 1865)