Airborne *Campylobacter* infection in a poultry worker: case report and review of the literature

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**Summary:** A man who had recently started work as a packer in a chicken factory developed *Campylobacter* enteritis with severe complications. This prompted a qualitative assessment of the occupational infection risk. It is likely that his infection occurred by droplet transmission via the mouth. Serological studies have shown increased risk of infection to poultry workers, particularly in the first weeks of employment. Previous reports have identified the risks of airborne pathogen transmission, and these papers are reviewed here. Epidemiological evidence from the plant indicated that workers were three times more likely than the general population to suffer *Campylobacter* enteritis, and occupational health reporting confirms the risk to poultry workers. Employers should offer face masks to their workers for protection from airborne infection.

**Key words:** airborne *Campylobacter* infection mask poultry worker risk transmission

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The medical history

In 1999, a 33-year-old male commenced employment at a large poultry producer. His work involved handling chilled chicken carcasses conveyed on hooks to his workstation at around face height. Carcasses were dropped through a funnel onto a conveyor belt and splashing took place onto the operatives who were trussing and packing. Around five weeks afterwards he began to suffer flu-like symptoms. One week later he developed diarrhoea, approximately every two hours, which his general practitioner (GP) treated with loperamide. He was subsequently admitted to hospital where he developed much more severe symptoms and debilitating complications, including toxic megacolon, which necessitated an emergency subtotal colectomy and associated surgical procedures. *Campylobacter* infection was confirmed from a stool culture. Close questioning revealed no known or likely exposure to *Campylobacter* other than working with poultry. The patient remained in hospital for approximately one month. Postoperative complications developed and required readmissions and a series of surgical interventions over more than a year to address recurring infection. He became unable to work and, although previously fit and active, is prone to develop long-term problems because of this infection and surgery. In a few cases of *Campylobacter* enteritis, treatment with loperamide has been shown to be a predisposing factor to the development of toxic megacolon.

**Epidemiology**

In 1999, five confirmed cases of *Campylobacter* enteritis were recorded at the factory where the subject worked. This was 0.34% of the mean factory workforce (1,450). There were 55,000 cases in the general population of 52 million in England and Wales in 1999 (0.11% of the population). Assuming the workers in this factory were three times more likely to contract *Campylobacter* enteritis than members of the general population ($\chi^2$, 2-sided $p = 0.016$), the difference is extremely unlikely to be due to chance and can be attributed to their greater exposure to *Campylobacter*. However, these figures may have been affected by ascertainment bias with workers more likely than the general population to report illness because of the requirement not to work while suffering enteric symptoms, or under-reporting because low paid workers would lose wages while absent. In this particular case, the patient continued to work for one week with flu-like symptoms before diarrhoea developed, which may suggest under-reporting in the industry.

The reportability of infection in the United Kingdom (UK) is governed by legislation. The *Food Safety (General Food Hygiene) Regulations 1995* require food workers to report certain illnesses to managers where there is a possibility of food contamination. The *Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995* (RIDDOR) require notification of *Campylobacter* infection only if the diagnosis is confirmed by a medical practitioner. Under the *Public Health (Control of Diseases)*
Act 1984, campylobacteriosis is notifiable to a consultant in communicable disease control, but only if acquired from food. Between 1996 and 2003, 469 cases of occupational campylobacteriosis were reported to the Surveillance of Infectious Disease At Work (SIDAW) scheme, which is part of The Health and Occupation Reporting network (THOR: http://www.coeh.man.ac.uk/thor). The most common occupational group was poultry dressers, constituting 17.5% of the total. Occupational campylobacteriosis has also been recorded in others working with animals, meat and food (Raymond Agius, personal communication, January 2004).

Carcass contamination with Campylobacter

Skirrow first described human campylobacteriosis in 1977, and some of his cases were apparently infected from chickens. Numerous studies have since shown that Campylobacter infection is common in poultry flocks, some studies indicating flock infection rates of 100%; certain flocks have been found to be free from infection, however. The hazards of poultry production have been investigated (ACMSF) which acknowledged high levels of Campylobacter species being present in the majority of chicken carcases. There are considerable differences between studies because of variations between countries, and differences in the stages of sampling in the production chain, in the part of chicken sampled, in the microbiological methods, and in other variables. Most birds become colonised by their third or fourth week of life and do not show the clinical symptoms of infection seen in humans. By the time of slaughter few remain uninfected. The slaughter, scalding, defeathering, evisceration and chilling processes ensure that the bacteria are spread almost universally through carcasses being processed. Campylobacter is therefore present in the majority of chicken carcases.

Company health and safety procedures

The patient stated that textile white coats, Wellington boots, and three-layer protective gloves were issued, but no protection was provided for the operative’s face. Induction training allegedly included no mention of the risk of contracting infections from the carcasses, and personal protective equipment seems to have been aimed at ensuring protection of the product from human contamination rather than the reverse. This is demonstrated by the fact that bearded operatives were told to wear masks, but none were offered to clean shaven workers. Washing and removing gloves at meal breaks could provide an opportunity for further aerosolisation of the bacteria contaminating gloves. The patient said he was particular about personal hygiene and followed the training he was given. With the high contamination rate of raw poultry, which must be subjected to a bactericidal cooking process before consumption, the training shows that the evaluation of risk was biased towards the consumer. While the consumer, by careful separation and cleaning, should be able to avoid cross contamination in the domestic environment prior to cooking, it is probably impossible for poultry workers to avoid exposure to pathogens on chickens. A more appropriate risk evaluation would consider the risks to the workers and the consumers independently.

Infection transmission and its control

Campylobacter is the most common bacterial cause of gastrointestinal infection, but the source of infection is frequently elusive. A recent large study estimated that seven unreported cases of campylobacteriosis occurred for every one that was reported to the Public Health Laboratory Service (now the Health Protection Agency), Communicable Disease Surveillance Centre. Most cases are sporadic, and epidemiological evidence is frequently derived from food histories and case-control studies rather than microbiological isolation of the organism. Chicken is now thought to be responsible for a smaller proportion of campylobacteriosis in the general population than was earlier believed, but this would not be the case for poultry workers who spend their working days in a contaminated environment. The patient stated that he handled over 400 birds per day and their contamination rate was 99%. This corresponds to continuous exposure to Campylobacter.

The minimum infectious dose of Campylobacter is very low, estimated at 500 to 800 organisms. The Danish Veterinary and Food Administration conducted a quantitative risk assessment of human campylobacteriosis from chickens, using these figures. There is little doubt that almost all cases occur by the oral route, but a few serious infections are possibly of extraintestinal origin. Primary pneumonia due to campylobacters appears not to have been reported. Bacteraemia is uncommon and may be transient during enteritis, secondary to a focal infection, or chronic in immunocompromised patients. Hand-to-mouth contact would be capable of causing infection, but the patient denied this. Splashes and aerosols would also be able to transmit an infectious dose. The patient reported that at times chickens he packed were wet and arrived in tubs with ice. The trussing operation, which involved forcing the leg parts into the body cavity and using rubber bands, would be capable of distributing infected droplets if the birds were wet, and possibly smaller infected airborne particles if the birds were dry. These possibilities are supported by serological evidence of human infection, experimental confirmation of airborne transmission of Salmonella between chickens, and microbiological evidence of colonisation of workers.

Serology

Raised levels of anti-campylobacter antibodies have been shown to be protective against subsequent infection. A study in Manchester found that groups of people, mainly poultry workers, who had occupational contact with Campylobacter through infected animals had much higher levels of antibodies than the normal population. The immune response approached that of individuals who suffer periodic Campylobacter enteritis because of regular consumption of unpasteurised milk. Two per cent of antenatal patients
in Manchester and 5% in more rural Norfolk were found to have anti-campylobacter antibodies compared with 18% to 68% of animal workers. There is a significant increase in anti-Campylobacter antibodies in those who have worked in poultry plants for more than one month over those who have worked for less than a month and over blood donors with no special exposure to chickens. These studies suggest either that hand-to-mouth contact is not necessary to transmit Campylobacter, or that hand-to-mouth transmission is very common indeed among workers. In either case, face masks are necessary to control infection despite their lack of comfort.

In the moist, Campylobacter-laden chicken processing environment it is quite plausible that an infectious dose could be transmitted by small airborne droplets generated from the movement of wet carcasses. An infectious dose could enter the mouth from splashes or smaller airborne droplets. Gastrointestinal infection could then result from swallowing oral secretions. This has not been demonstrated directly, but it is consistent with evidence that poultry workers develop a serological response to Campylobacter within a month of working in a poultry plant. While enteric exposure to the organism appears to be common in poultry plants Campylobacter lung infections are uncommon and originate from haematogenous spread or focal infections. Since Campylobacter primary pneumonia has not been identified as an occupational hazard to poultry workers, the principal mode of airborne spread is probably by swallowed droplets rather than smaller particles breathed into the lungs.

The work of Cawthraw et al. indicates that occupational exposure leads to an immune response to Campylobacter antigens that may be protective against some or all future infections. It therefore appears that poultry workers are at most risk of developing Campylobacter infection in their first weeks of working. After a period of exposure they develop immunity that may be generally protective against symptomatic infection, although probably not against colonisation. Operatives’ diarrhoeal episodes decrease over time while working in such factories. This may explain why factory managers do not consider Campylobacter infection as a major risk. It would also explain why the patient, a new worker, succumbed.

**Airborne transmission**

Guidance prepared by the Food Standards Agency recognises the spread of pathogens by modes including airborne transmission:

*’Bacteria from the surface or digestive tract of an animal may be transferred onto the carcass or unto other carcasses during slaughter and dressing. This transfer may be caused by direct contact or through cross contamination by slaughterhouse staff, equipment, surfaces, water or aerosols’.*

Bacteria in aerosols may remain airborne for minutes and even hours with smaller particles. Salmonella infection between birds in poultry flocks has been shown to occur by airborne transmission of small-particle aerosols. Greater infection was found in the muscles and eggs of chickens that were infected by the aerosol route than via the crop. The spread of enteropathogenic organisms has been demonstrated to extend over 40 cm during the preparation of egg dishes in the kitchen. Campylobacter is a much less robust organism than Salmonella, but similar airborne transmission characteristics are possible, and Campylobacter and Salmonella share the same recommendation for laboratory containment level 2.

It would not have been necessary for the patient to put his contaminated hand to his mouth, although this also is a possible mode of infection. He claimed to be particular about personal hygiene and denied the possibility of hand-to-mouth transmission, but this is beyond verification.

The National Agricultural Safety Database (USA) recognises high concentrations of bacteria in poultry-processing aerosols and their hazard to workers:

*‘The emission of airborne particles with pathogenic and spoilage microorganisms in poultry slaughtering and processing plants can create high airborne concentrations. It is important to keep these unwanted bioaerosols from processing and packing areas to assure product quality and safety and the health and well-being of plant workers’.*

There is an absence of studies specifically of new poultry workers, and work is needed in this area. There is no direct evidence of the value of face protection in preventing the transmission of campylobacteriosis, but, despite different transmission characteristics, it is worth considering the role of masks in preventing other infections. Veterinarians performing necropsy on chickens are advised to consider gloves and a face mask where a disease transmissible to humans is a suspected cause of illness or death. Poultry plants currently do not require operatives to wear face protection for this type of work, although some chicken workers on farms wear masks, chiefly to protect themselves from dust and allergic lung diseases.

Recently reported cases of viral infection have emphasised the importance of face protection. A veterinarian in the Netherlands developed an eye infection after visiting farms infected with Highly Pathogenic Avian Influenza (HPAI) H7N7. As a result of this, the coordinator of communicable disease control for the Netherlands advised all workers involved in culling of poultry to wear eyeglasses and mouth masks. A veterinarian who had visited an affected farm later died of pneumonia resulting from this infection. An investigation of severe acute respiratory distress syndrome (SARS) found that 69 staff who were diligent about the use of masks, gloves, gowns, and hand washing were not infected, whereas all 13 infected staff omitted one or more of these measures. Masks were the only one of the four measures that was statistically significant in protecting staff. Paper masks that become saturated were less effective than surgical masks. In this case spread was considered to be via droplets rather than smaller aerosol particles. While certain viruses are more infective by the airborne route than Campylobacter, the importance of personal...
original reports

The infectious dose for _C. jejuni_ may be low in many cases, but data are not currently available that clarify the relationship between the dose ingested and the risk of disease symptoms. Limited information is available from feeding studies, but there is much uncertainty surrounding dose response and exposure assessment estimations, particularly at low dose levels, and strain and patient variations. Investigation of postal transmission of _Bacillus anthracis_ infection by using mathematical modelling illustrates the risk from a possibly comparable low concentration, low infectious dose, and low attack rate airborne infection.

Campylobacteriosis is widely recognised as an occupational infection. An expert committee has stated that occupational exposure to _Campylobacter_ is a potential health hazard. Prior to an outbreak in Sweden, inexperienced teenage holiday workers had recently taken the place of regular poultry factory staff. _C. jejuni_ was isolated from 24 of 37 individuals affected. Of the new staff, 71% contracted the infection compared with 29% of experienced staff. Five other staff were asymptomatic carriers, and secondary spread between workers was found in three cases. The difference in attack rates between inexperienced and experienced staff probably reflects both their manual skills and immune status. Seven of nine casual farm workers in Canada developed campylobacteriosis after catching and transporting asymptomatic turkeys. Unlike their colleagues, the two uninfected workers did not eat or smoke while they worked, and drank only bottled water from home. Four permanent workers were also affected. A study in Norway found _Campylobacter_ in the intestines of 100% of 97 pig carcasses, and the authors commented that this might be an occupational health hazard. A _Campylobacter fetus_ spp. _fetus_ infection was reported in a previously healthy slaughterhouse worker who suffered relapsing fever with heart and lung involvement. His job involved hosing out animal carcasses, which would have generated aerosols, and manual removal of spinal cord. He admitted to damaging a glove, but the route of infection was not clear. A study in the United States found that 41% (7/17) of chicken catchers were colonised with _Campylobacter_, which is an abnormally high prevalence for healthy humans. The farm workers suffer from bouts of diarrhoea, which indicates, contrary to the serological studies cited above, that they have not developed protective immunity against all of the wide range of campylobacter serotypes they encounter. These researchers also identified the organism in the stools of 63% of poultry factory workers, and all of the community members who lived near but did not work on the poultry plant. These results, from 34 chicken workers and community residents, suggest that _Campylobacter_ is spread occupationally and by airborne transmission, which may be direct, or through the environment.

Conclusions

The foregoing case history establishes that potentially fatal occupational infections occur in the poultry industry. Scientific studies have shown serological, microbiological, and epidemiological evidence of increased _Campylobacter_ exposure, colonisation, and infection among chicken workers, particularly in their first weeks of employment. Face masks are not currently standard protective equipment in poultry processing plants, although the Health and Safety Executive recommends air-fed masks for pre-slaughter workers. Perhaps through ignorance, employers and employees are prepared to bear the health burden of this occupational illness. In the light of the patient’s infection and the increased level of diarrhoeal illness among chicken workers, employees should be instructed to wear masks and possibly eye protection, at least for the first months of work. Such measures may be cost effective by reducing sick leave. More frequent air changes with ultraviolet disinfection could lower the overall level of bacteria in the air. Further monitoring would be required to evaluate the occupational health and financial effectiveness of the measures. Certain masks may be of limited use if they become saturated with moisture since _Campylobacter_ is motile organism able to swim through such matrices. Surgical masks with high fluid resistance, high bacterial filtration efficiency (BFE), and clear plastic face protectors may be the most suitable option for daylong use. Masks would limit hand-to-mouth contact and could be used as sampling devices that could be submitted to microbiological examination, to evaluate the risk of airborne infection in future studies.

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References


