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A study of the spread of *Campylobacter jejuni* in four large kitchens

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SUMMARY

Campylobacters were sought in swabs taken from work surfaces, sinks and floors of four kitchens–i.e. hospital, university, cook-freeze and commercial, processing frozen or fresh chickens. Each kitchen was visited on four occasions. In the large commercial kitchen environmental contamination was found on each visit, whereas campylobacters were isolated on six of the twelve visits to the other kitchens. The hands of operatives were contaminated with campylobacters on only two of the 45 swabs taken during processing. Cleaning with detergent and hot water (or steam) and drying appears to be sufficient to remove the organism from the environment.

Evidence of carriage of campylobacters by the birds was obtained on all 16 visits. In the three kitchens where only frozen birds were used the organism was isolated from 30% and 9·8% of swabs taken from the internal and external surfaces respectively, while 41% of giblets and 22·2% of thawed juices yielded campylobacters. The external surface of 30 (88%) of 34 fresh birds grew campylobacters.

INTRODUCTION

Although it is six years since attention was drawn to *Campylobacter jejuni/coli* as a cause of gastroenteritis in man (Skirrow, 1977) the epidemiology and transmission of the organism has not been fully determined. The route of infection is by ingestion of the organism, and whilst in most large outbreaks the vehicle has been identified as milk (Robinson *et al.* 1979; Robinson & Jones, 1981; Jones *et al.* 1981) or water (Mentzing, 1981; Vogt *et al.* 1982; Palmer *et al.* 1983) in almost all sporadic cases the route of transmission is not identified even if a particular food item is suspected. Only a few outbreaks have been ascribed to meat (Oosterom *et al.* 1980; Anon, 1982) or poultry (Hayek & Cruickshank, 1977; Brouwer *et al.* 1979; Skirrow, Fidoe & Jones, 1981, Mouton *et al.* 1982), yet these products have been shown to be heavily contaminated immediately after slaughter (Stern, 1981; Bolton, Dawkins & Robertson, 1982; Smeltzer, 1981; Luechtefeld & Wang, 1981; Shanker *et al.* 1982). Campylobacters survive deep freezing (Svedham, Kaijser & Sjogren, 1981) but do not multiply at the normal storage temperature (4 °C) of meat and fresh poultry products (Doyle & Roman, 1981; Blankenship & Craven, 1982). The organism is susceptible to pasteurization (Waterman, 1982) and should be readily killed at normal meat cooking temperatures.

These features suggest that dissemination of the organism may occur through contamination of the environment and the hands of kitchen personnel with subsequent cross-contamination of prepared food. This study was undertaken to determine if surrounding work surfaces and more particularly the hands of kitchen personnel became contaminated whilst defrosting and preparing birds for cooking. Four catering establishments processing small and large numbers of fresh and frozen chickens were examined. The methods used to clean the working areas after preparation were noted and their effectiveness discussed.

MATERIALS AND METHODS

Design of study

The four kitchens chosen were as follows.

A hospital kitchen which prepared hot and cold meals for 500 patients and 1000 staff. Batches of 20 frozen chickens were prepared two and three times weekly. Surfaces were cleaned using hot water and detergent and wiped dry.

A university kitchen catering for students, staff and professional conferences. Hot and cold dishes were prepared twice weekly. Normally a small batch of 20 frozen birds was processed but occasionally 100 birds were handled. Surfaces were cleaned using hot water and detergent and wiped dry.

A cook-freeze unit which prepared cooked meals in bulk which were blast frozen. Up to 100 frozen chickens were processed on any one occasion. Surfaces were cleaned using hot water and detergent and wiped dry.

A commercial roast chicken unit which processed up to 9000 fresh and frozen chickens daily. The chickens were steam roasted, blast frozen, portioned and packed for the catering trade as frozen roast chicken. The floor and surfaces were cleaned using detergent and a steam lance and then dried.

Each kitchen was visited on four occasions. All frozen chickens were thawed for 24 h before being processed. The pattern of sampling was essentially the same in all kitchens though the number of swabs taken in each kitchen varied depending on its size and layout. The surfaces and sinks surrounding the preparation area were examined (i) before work commenced, except that in the commercial kitchen different work practices made it impracticable to collect swabs prior to starting work; (ii) during the processing of the chickens; (iii) after the completion of the cleaning routine. The operators' hands were swabbed before and during preparation, and after washing. Surface swabs of the outside and inside of five chickens were taken on each visit. Giblets, when present, were removed and placed in a sterile container for transport to the laboratory and accumulated juices after thawing were likewise collected into sterile containers.

Environmental samples were collected by wiping work surfaces, floor or hands with a 5 cm square sterile cotton gauze. Sampling was carried out wearing plastic gloves which were washed and dried between samples. All swabs were placed immediately into 60 ml screwtopped jars containing Preston modified enrichment broth (Bolton *et al.* 1983). Thawed juices were poured into an equal volume of the broth, and giblets were placed whole into 60 ml jars of the same medium. The tops of all jars were tightened before being incubated at 42 °C for 24 h. These were subcultured on to Preston agar and incubated in microaerobic conditions at 42 °C

Table 1. *Isolation of campylobacters from four kitchens before, during and after processing chickens*

	Kitchen				Total specimens examined
	Hospital	University	Cook-freeze	Commercial	
Before processing					
Environment	0/23*	0/18	0/17	ND	0/58
Hands	0/5	0/7	0/7	ND	0/19
During processing					
Environment	2/13	1/15	1/11	17/23	21/62
Hands	1/14	1/16	0/15	ND	2/45
After cleaning					
Environment	0/8	0/9	0/14	1/19	1/50
Hands	0/4	0/5	0/4	0/1	0/14

* Number of isolates/number of specimens examined. ND, Not done.

for 48 h. Suspected campylobacter isolates were identified by a positive oxidase test and typical morphology and motility on dark-field microscopy. Cultures were biotyped by the method of Skirrow & Benjamin (1980) and serotyped by Dr D. M. Jones (Manchester).

RESULTS

The number of isolations of campylobacter organisms from the environment before and during processing and after cleaning is shown in Table 1.

In the three kitchens where it was practicable to sample before processing commenced the work surfaces, floors and hands of the operators were free from campylobacters.

Campylobacter species were isolated from carcasses, giblets or juices on 15 of the 16 visits. On the single occasion when no isolation was made from the birds campylobacters were isolated from the work surface and the hands of an operator.

The environment was found to be contaminated during processing at each of the four sampling visits to the commercial kitchen. Campylobacters were recovered from the environment or the hands of an operative on six of the twelve visits to the other three kitchens.

Specimens collected after hand washing were negative, as were all but one of the environmental swabs taken after cleaning. This single isolation was made from the floor of the raw preparation area in the commercial kitchen after the cleaning routine had been undertaken but not completed.

In the commercial kitchen a corridor separated the area used for the preparation of raw chickens from that area where cooked birds were blast frozen, portioned and packed. The opportunity was taken to sample this latter kitchen. From 30 environmental swabs a single isolation was made from the floor of the cooked bird preparation area during processing procedures. Swabs of several cooked birds did not yield campylobacters, and after cleaning the environment was free of the organism.

The number of isolations of campylobacter from carcasses, giblets and juices is

Table 2. *Isolation of campylobacters from chickens*

	Kitchen			Total	Percentage positive
	Hospital	University	Cook-freeze		
Chickens					
Inside	5/20*	5/20	8/20	18/60	30
Outside	0/20	2/20	4/21	6/61	9·8
Giblets	11/25	8/21	4/10	23/56	41·1
Juices	4/15	5/16	1/14	10/45	22·2

* Number of isolates/number of specimens examined.

Table 3. *Biotypes of* 114 *campylobacter isolates from the kitchen survey*

	Number of each biotype			
Kitchen	*C. jejuni* 1	*C. jejuni* 2	*C. coli*	*C. laridis**
Hospital	10	2	6	4
University	7	1	14	0
Cook-freeze	16	0	2	0
Commercial	42	0	10	0

* Benjamin *et al.* 1983.

shown in Table 2. In the first three kitchens swabs were taken of both inner and outer surfaces of the same chicken: 9·8 % of the external swabs grew campylobacters compared with 30 % of swabs from the inside of birds. Giblets gave the highest isolation rate (41 %) whilst 22·2 % of the juices examined were positive. In the commercial kitchen the outsides only of 34 carcasses were examined. Of these 30 (88 %) were contaminated with campylobacters.

The *Campylobacter* species and biotypes (Skirrow & Benjamin, 1980) isolated from the survey are summarized in Table 3. Sixty-six per cent of strains were *C. jejuni* biotype 1 and 32 (28 %) *C. coli*. Only three strains of *C. jejuni* biotype 2 and four strains of *C. laridis* (Benjamin *et al.* 1983) were isolated.

Fifty-two of the isolates were serotyped using the passive haemagglutination technique for heat-stable antigens described by Penner & Hennessy (1980). The distribution of the serotypes found in isolates from chickens and from the environment is shown in Table 4.

DISCUSSION

Campylobacter food poisoning in association with chickens has not been commonly reported, although the possibility has undoubtedly been considered in most outbreaks. The lack of aerotolerance and the susceptibility to heat of campylobacters probably ensures that even inadequately cooked birds are unlikely to transmit infection directly. That chickens are a major source of campylobacters is shown by their isolation from carcasses on 15 of the 16 kitchen visits and their recovery from the environment on the remaining occasion. Their potential to

Table 4. *Distribution of campylobacter serotypes from chickens and surface samples from four kitchens*

Kitchen	Serotypes from each source	
	Chickens/Giblets/Juices	Surfaces/Utensils
Hospital	6·7, 11, 24, 46, 49, NT	10, 49, NT
University	1, 9, 13, 16, 24, 28 NT	8, 9, NT
Cook-freeze	5, 9, 46, 55, NT	6, 27
Commercial	1, 2, 4, 19, 37, 39·46, 55, NT	1, 2, 19, 37, 39·46, 44, NT

NT, Not serotypable.

contaminate the kitchen environment and thus cross-contaminate other foods is illustrated by our findings.

The study demonstrates that when campylobacters are introduced into a kitchen preparation area on fresh or frozen chicken the surrounding work surfaces are very likely to become contaminated. It was not unexpected to detect environmental contamination on each sampling visit to the commercial kitchen due to the sheer volume of birds that were processed each day. Moreover, as no other type of food preparation proceeded in that area the operatives did not have the constraints applicable to the chefs in the other three kitchens where working procedures to avoid cross-contamination are encouraged if not enforced. Even so good kitchen practice did not prevent the detection of environmental contamination on half of the visits to the kitchens processing small or moderate numbers of birds. Therefore, if processed food is placed on these surfaces before the surfaces have been cleaned there is a high probability of organisms being transferred. As the infective dose of campylobacters would appear to be small (Robinson, 1981) this route of infection is very feasible.

Campylobacters were isolated from hand swabs of the operatives during the preparation of the carcasses, but proof of contamination was not detected as frequently as might have been anticipated. The probable reason for this low level of isolation was the use of running water over the operatives' hands whilst cleaning the chickens. Nevertheless, the isolation of the organism from swabs of the operatives' hands highlights a potential method of dissemination of the organism. The operative could infect himself by putting his unwashed hands to his mouth, e.g. smoking or by handling food which he subsequently eats. This latter method of contamination of food could also account for people other than the operative becoming infected.

The absence of campylobacters on work surfaces all of which were dry preparatory to defrosting and handling of the birds was to be expected, as campylobacters die off quickly in dry conditions (Doyle & Roman, 1982). The importance of drying surfaces and floors after washing was demonstrated by the

single isolation made from the floor of the commercial kitchen. In this instance the swab was taken from a pool of water before the floor had been sponge dried. Other areas sampled at the same time were dry and campylobacters were not isolated. Apart from this single isolate the effectiveness of simple cleaning procedures using detergents and hot water or steam was confirmed by our inability to recover the organism from the environment or hands after washing.

The importance of swabbing the inside of birds in environmental and epidemiological studies was demonstrated by comparing the isolation rate from internal and external swabs of the same carcass. Campylobacters were recovered three times more frequently from the inside than from the outside of the birds. The isolation rates from both the inside and outside of chickens, the giblets and juices does not imply the same carriage rate among live chickens, but rather reflects the increased contamination that must inevitably occur in all production-line killing of chickens. Moreover, the practice of pooling giblets before they are trimmed and inserted into the birds must increase the possibility of cross-contamination of carcasses.

The commercial process used up to 9000 birds in one day and the majority were freshly killed, though frozen birds were used when a shortfall was anticipated. In this kitchen we swabbed only freshly killed birds, and the high proportion (88 %) of birds with campylobacters on their outer surfaces contrasts with the 9 % isolation rate from the other three kitchens where only frozen carcasses were examined. The most probable explanation for these findings is that on the fresh birds the campylobacter organisms had survived because the time interval between slaughtering and arrival in the unit for processing was short. Moreover, it was noted that many of these fresh carcasses were visibly stained with faeces.

The majority of human campylobacter infections are associated with *C. jejuni*, although infection with the other species is not uncommon. Because of the preponderance of *C. jejuni* infections it is essential for epidemiological purposes to be able to recognize similar strains. To date most experience has been gained using serotyping schemes (Penner & Hennessy, 1980; Lior *et al.* 1982), although recently three new biotyping schemes have been reported (Hebert *et al.* 1982; Bolton, Holt & Hutchinson, 1983; Lior, 1983). The serotyping results (Table 4) showed that the majority of the serotypes isolated from surface swabs were present in the chickens sampled from the same kitchen. The non-serotypable strains were further biotyped using the Preston biotyping scheme (Bolton, Holt & Hutchinson, 1983) and it was evident that strains isolated from individual kitchens were the same biotype (unpublished observations). Surprisingly, serotypes 1, 2 and 4 – which are most commonly isolated from human campylobacter infections in the U.K. – were found in only a few of the survey samples. Nevertheless, the variety of serotypes isolated does reflect those found in sporadic infections (Abbott *et al.* 1983).

It is not always correct to extrapolate one's findings without doing the research, but from this study we would expect that contamination of work surfaces takes place in the home kitchen. It would therefore be reasonable to assume that cross-contamination or careless personal hygiene in the home may account for many of the sporadic campylobacter infections.

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