

SPECIAL ARTICLE

The carrier food-handler and non-typhoid salmonellosis

The number of reported cases of food poisoning and food-borne disease continues to increase in most countries. The published figures are recognized as being only a small fraction of the true total and the problem is clearly both very large and international.

Of the variety of micro-organisms responsible for outbreaks, *Salmonella* spp. are by far the most frequently incriminated and in the United Kingdom these organisms cause over 90% of cases (Epidemiology, 1986). The almost universal presence of these organisms in certain common foods, their ability to grow in a wide variety of foodstuffs over a substantial temperature range, the ease with which dissemination occurs from person to person and the prolonged period of excretion following recovery are the properties which, taken together, distinguish *Salmonella* spp. from other food-poisoning organisms. It is because of these characteristics that salmonellas are really the only food-poisoning organisms in which human beings as carriers pose potential problems as sources of outbreaks. This review is, therefore, confined to a consideration of the practical significance of the faecal carriage of salmonellas by asymptomatic food handlers, to an evaluation of the degree of risk, if any, that such a person may pose and to an assessment as to whether the time and money devoted to the investigation and exclusion of such persons is well spent.

Most food-poisoning outbreaks are associated with forms of mass catering, whether the food is eaten *in situ* or purchased for later consumption at home (Roberts, 1982). There is justifiable concern in both the food industry and the various regulatory authorities, over the scale of this problem. In their understandable desire to effect meaningful reductions in the incidence of food poisoning in general and salmonellosis in particular, many preventive regimens have been adopted which vary in the degree in which they can be scientifically supported. One such would appear to be a gross over-emphasis in many quarters on the role of the food handler as a disseminator of food-poisoning organisms.

In an attempt to clarify the position consideration must first be given to certain features of salmonellosis which are directly relevant to the likelihood, or otherwise, of transmitting infection. These are the carrier rate in the normal healthy population, the duration of excretion and the number of organisms excreted in relation to what is known about the infective dose of non-enteric salmonellas.

The carrier rate

Not surprisingly, there are but few estimates of the general carrier rate and only two studies have been directed specifically towards the problem. Edwards *et al.*

(1964) suggested that between two and 50 persons per 1000 of the population in the United States might be carriers, depending on the locality. In the United Kingdom a survey by the Public Health Laboratory Service and Medical Officers of Health in 1965 (PHLS and Society of Medical Officers of Health, 1965) on well children under the age of five years found that 37 (0.15%) out of 25 249 were excreting a salmonella, 83 (0.33%) a shigella and 602 (2.42%) one of the then recognized pathogenic serotypes of *Escherichia coli*. The largest study was made in Tokyo (Sakai, 1978) on 4462 287 stools of which 6029 (0.15%) were salmonella positive. Perhaps, however, the most interesting figure is that quoted by Buchwald & Blaser (1984) who calculated that assuming about 2×10^6 salmonella infections in the United States each year, and an average duration of excretion of five weeks, there will be about 200 000 excretors in the population at any one time. If this figure is correct, there may be approximately 50 000 in the UK on the basis of a four times smaller population. The greater majority of the carriers would be short-term convalescent excretors and thus the numbers of long-term carriers are likely to be very small indeed, accepting of course that the figures can only be regarded as gross approximations.

Duration of excretion

Buchwald & Blaser (1984) reviewed studies on the duration of excretion of non-enteric salmonellas and concluded that in general terms 50% of cases were cleared of carriage by five weeks after the initial infection and 90% by nine weeks. There were wide variations between individuals which were unpredictable and some between patient groups which were more generally recognized. Neonates will often carry for long periods or until an adult diet is instituted (Epidemiology, 1978) and children for longer than adults. Children may excrete large numbers of salmonellas for weeks, or months, in early convalescence, i.e. 10^6 – 10^7 organisms per gram of faeces; whereas adults tend to excrete much smaller numbers within a week or two of clinical recovery (Schothorst & Beckers, 1978). Pether & Scott (1982) found that 10 of 25 adult convalescent patients were still excreting 10^3 or more organisms after three weeks but by 35 days those in whom organisms were still to be found had 10^2 or less salmonellas per gram.

Infective dose

The dose of organisms needed to initiate an infection may have some relevance to this problem. In a number of well-documented outbreaks in which four clinically ill food handlers have been clearly implicated, the time interval between handling (and contamination) and the serving of the food has been short enough for only limited proliferation to have occurred suggesting gross contamination initially. In studies summarized by Blaser & Newman (1982) it was shown that in volunteer experiments doses of 10^5 – 10^7 organisms were required to produce illness. In outbreaks there was a far wider variation in the calculated doses from less than 100 in pancreatin (*S. schwarzengrund*) to 10 000 in ice-cream (*S. heidelberg*), to over 10^6 in carmine capsules (*S. cubana*). With some foods, particularly dairy products, where it has been possible to measure the infective dose, it has been remarkably low. For example, in a *S. napoli* outbreak where the vehicle was chocolate, the infective dose was estimated to be as low as 10–20 organisms (Gill *et al.* 1983) and

in another outbreak caused by *S. typhimurium* in Cheddar cheese, even lower figures were estimated (Fontaine *et al.* 1980).

Clearly wide variations in response occur in which the host, serotype, dose, vehicle and other factors will play a part, and as might be expected the higher the dose the shorter the incubation period and the greater the attack rate. The demonstration that so few organisms could initiate infection may lend to unwarranted credence to the belief in the potential danger of the carrier food-handler.

Transmission

The transmission and survival of enteric organisms from convalescent excretors to their fingers and thence to foods was investigated by Pether & Gilbert (1971). A small inoculum of *S. anatum* was still recoverable from fingers three hours after contamination; a rather larger inoculum could be recovered after a 15-second hand wash. Even 100 organisms could, after 10 minutes on fingers, infect samples of meat. Salmonella were detected on the hands of convalescent excretors after defaecation but only after rinsing their fingers in broth, i.e. not on direct plating. After a simple soap and water hand wash organisms were no longer recovered from the convalescent carriers (Pether & Scott, 1982). De Wit & Kampelmacher (1981) compared the carriage of enteric organisms on the hands of workers in the food industry with that in other industries. They concluded that the high rate in the former and the low rate in the latter indicated that hand carriage was determined by occupational exposure and was not a problem arising from toilet habits.

Consideration of these factors in the transmission of salmonellosis leads to the conclusions that (a) the carriage of non-typhoid salmonellas in the general population is rare and if those recently convalescent from an attack of gastro-enteritis are excluded, very rare, (b) that in adults who are convalescent the numbers of salmonellas excreted in the faeces falls within a few weeks to levels which are below those needed *per se* to cause illness with the majority of strains, except after substantial proliferation in the contaminated food and (c) good and simple hygienic practice will stop the chain of transmission from faeces to fingers to food.

Food handlers

The food handler may pose a hazard potentially in three ways – as a patient, as a passive transmitter, or as a carrier.

No person in the catering industry with diarrhoea should be permitted to work while he continues to have symptoms. Whether or not the organism turns out to be a salmonella, 24 to 48 hours will be needed to confirm a diagnosis and as organisms are excreted in very large numbers in loose stool, the chances of contaminating the environment and facilities used by others must be fairly high.

Non-carrier transmitters of infection transfer food poisoning organisms passively from an infected source, e.g. poultry, to food by such means as unwashed hands but they are not themselves sources of the infection. Most episodes of food poisoning, be they outbreaks or sporadic cases, probably involve failures of this sort in food hygiene practices.

In the past asymptomatic food handlers have frequently been blamed as the

sources of outbreaks of food poisoning. Abrams *et al.* (1966) refer to four surveys in which 15.5, 29.6, 45 and 63% of the outbreaks were attributed to such persons and even in 1973, 10 out of 54 known long-term carriers were said to be responsible for cases or outbreaks (Musher & Rubenstein, 1973). Critical evidence is, however, extremely rare and there may have been some confusion in distinguishing between victims of an outbreak and its source. In recent years careful analysis has suggested that asymptomatic food handlers are rarely, if indeed ever, responsible for initiating outbreaks of food poisoning.

It is our thesis that, except after enteric fever, any adult having a solid formed stool after recovery from an attack of diarrhoea and who has good hygienic habits, does not need to be excluded from any form of work including food handling and that repeated follow-up stool cultures are unnecessary.

Scientific evidence to support this contention is difficult to come by as it is based on what has not happened, rather than what has. No prospective trials have been carried out and it would probably be difficult to satisfy ethical committees even if a protocol could be worked out. Roberts (1982) studied in retrospect 1479 outbreaks of food poisoning in the UK in which the cause could be reasonably ascertained, between 1970 and 1979. In 44 caused by *Staphylococcus aureus*, actively infected food handlers were cited as the likely sources. In only nine salmonella outbreaks out of a total of 792 were food handlers thought to be the source. Seven were suffering from diarrhoea at the time and the other two had recently returned from Spain; their condition at the time was not recorded. In many other incidents food handlers have been shown to be infected, but on investigation were clearly themselves victims of outbreaks and not the sources. In no case from any cause was an asymptomatic food handler unequivocally implicated. It is perhaps significant that in the analysis of food-borne disease in the UK in 1983 and 1984, in which 11 099 and 13 250 cases of salmonellosis were notified respectively, no mention is made of food handlers (Epidemiology, 1985, 1986).

Charles (1985) reckons that less than 5% of outbreaks are due to infected food-handlers and virtually all of these have staphylococcal lesions where there is active infection rather than carriage. A WHO Working Group (1979) held similar views.

The investigation of a dried milk outbreak due to *S. ealing*, which infected babies all over the UK, involved the examination of specimens from the whole current work-force of around 350 with totally negative results. One carrier was subsequently discovered in an employee who had left the factory before the outbreak began (Hutchinson, personal communication). Negative evidence such as this is hard to substantiate, but that there are remarkably few outbreaks associated with commercial food processing concerns which with the huge labour forces involved might be said to argue against asymptomatic carriers as significant sources.

However, the public are not wholly impressed by such evidence, and further, the rules are not decided by the scientists but by the legislators. In a recent court case reported by Bush (1985) a man working in a food-processing factory appealed against a dismissal on the grounds that he was a salmonella carrier. He was involved in duties that did not, in the remotest way, involve any contact with food. The judgement while sympathetic to the scientific arguments put forward stated with awful finality '...but assuming these experts were right and that in

scientific terms the risk minimal, to say that it was unreasonable for a food manufacturer to refuse to employ in his factory a person who is known to be infected with salmonella, and who if he were to touch any cooked food or any surfaces on which cooked food was placed or any food handler, could, if there had been the slightest lapse in the highest standards of hygiene, cause the infection to pass to the finished product, to say that in these circumstances it was unreasonable to refuse to employ such a person seems to be an affront to common-sense'.

One may disagree with such simplistic interpretations but they are a clear indication that the lay view is what determines the practice in the long run, whatever the scientific evidence may or may not be. There must be many hundreds of food handlers in canteens, restaurants and food factories each day who will go to work with, or have just recovered from, an attack of diarrhoea quite unbeknown to employers mainly from fear of dismissal. If such handlers were really menaces we should surely know by now.

However, for the moment a realistic solution demands a compromise and recommendations are set out in the PHLS Guidelines Document (Public Health Laboratory Service, 1983). In summary, they are:

(1) Where a food handler falls into the category of special risk of spreading infection, i.e. 'whose work involves touching unwrapped foods to be consumed raw or without further cooking', such a person should be excluded from that work following an attack of salmonellosis until three consecutive negative stool specimens have been obtained. A similar exclusion is placed upon persons recovered from shigellosis, but this condition is so rare a cause of food poisoning in the UK now (one case in 1984) that detailed consideration was not thought to be warranted. Incidentally, the only other exclusion is for seven days after the onset of jaundice in infectious hepatitis. Exclusion is not justified for any other organism including campylobacter.

(2) Where the food handler falls outside the special risk category, i.e. a person involved in any other aspect of food handling, neither follow-up nor exclusion need be carried out after he or she has a well-formed stool.

It must be emphasized that the above are recommendations for guidance and that each case must be reviewed on its merits. Factors that should be considered include the nature of the work, general personal cleanliness and hygienic practice of the individual, perhaps home circumstances, the availability and standard of ablution facilities at the place of work and the general workplace environment.

Contacts

From time to time contacts of convalescent carriers of salmonellas have been pilloried by employers and others. There is no evidence that contacts of cases of gastro-enteritis who are themselves well, constitute any form of risk and they should not be subject either to exclusion or to stool testing.

Pre-employment and routine physical and microbiological examinations for food handlers

At a WHO sponsored symposium in 1979 doctors responsible for food hygiene regulations from a number of countries compared policies with regard to health checks on food handlers. A variety of systems were in operation, most countries requiring, by law, pre-employment examination and rather fewer insisting on

further regular check-ups. The EEC legislation requires annual health certificates for persons in certain fields of food production – meat product plants, slaughter houses and poultry processing plants exporting outside the community. Guidelines were issued by the DHSS and a practical application of the regulations was proposed by Winter (1983) covering enteric infections, tuberculosis, infectious skin diseases and unhygienic activities. Stool examinations were only required if there was a history of diarrhoeic illness of 24 hours or more duration within the past three months. It would seem eminently reasonable to test stools from food handlers in certain circumstances, e.g. on employment when staff have come recently from countries with a high incidence of gastro-enteritic illness or where personal histories suggest past or recent enteric infections or where staff have had an attack of diarrhoea whilst on holiday in certain countries – and in other similar situations.

Routine stool examinations are still required for food handlers in some countries and by some employers in the UK. While it is argued that a few carriers of typhoid and non-typhoid salmonella may be detected, the experience in the UK of laboratories which have carried out such tests is that years may go by without finding a single positive. Tests are almost always on one specimen only, which will certainly reduce the likelihood of isolating a salmonella present in low numbers unless pre-enrichment is carried out – a very costly exercise. Several samples may be necessary to detect even 95% of carriers (Public Health Laboratory Service, 1961). In a recent holiday-island outbreak of typhoid, the carrier who had a history of the disease 20 years before was only identified on the second specimen (Stanwell-Smith & Ward, 1986). A negative finding may thus engender a false sense of security. Perhaps the most telling commentary is that where evidence is available, the routine testing of food handlers has not been cost effective in controlling food poisoning even in countries where carriage rates are much higher than in the UK (Bader, 1972; WHO Working Group, 1979). The cost of stool examinations for salmonella including enrichment for even a modest-sized workforce will run into thousands of pounds.

There is no justification for recommending routine stool testing for food handlers and we suggest that the enormous cost of doing so far better employed in other aspects of food hygiene, like education and improvement of premises and practices as advocated by Charles in 1982.

Conclusion

The concern of those in the food industry over employees carrying organisms capable of causing food poisoning is understandable and is clearly reflected in the overcautious policies adopted by some organizations. Rational consideration of available evidence fails to implicate asymptomatic food handlers with formed stools as sources of outbreaks of salmonella food poisoning. Unnecessarily harsh attitudes may, however, be counter-productive by encouraging staff to conceal illnesses, thereby creating real hazards.

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