

## **An outbreak of human infection due to *Salmonella typhi-murium*, phage type 4, associated with the use of unpasteurized liquid egg**

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### INTRODUCTION

*Salmonella typhi-murium* is the most common salmonella serotype associated with food poisoning in England and Wales (Reports, 1961, 1962). The major part of the disease due to this organism is sporadic in distribution. In 1961, for example, out of 2503 incidents due to *S. typhi-murium*, 2463 were either sporadic cases or family outbreaks.

Of twenty fatal cases of food poisoning reported in 1961, seven were due to *S. typhi-murium*.

Eggs and egg products, poultry and meat, are known to be often infected with *S. typhi-murium* and bakeries may become contaminated from such sources (Philbrook *et al.* 1960; Harvey & Philips, 1961). As Anderson (1962) has pointed out, tracing the source of *S. typhi-murium* infection is made difficult by the widespread reservoir of infection in livestock and also because food is often prepared in an environment which has been contaminated by infected raw materials. A single bakery may distribute its products widely so that if they are contaminated the epidemiological picture is one of multiple sporadic infections and the unified nature of the outbreak may be obscured.

The value of phage-typing in tracing the source of *S. typhi-murium* was demonstrated in an outbreak due to infected meat described by Anderson, Galbraith & Taylor (1961). In the outbreak of *S. typhi-murium* infection described here the source would have remained undetected without the aid of phage-typing. The cases were scattered throughout the south-east Lancashire conurbation and were associated with unpasteurized English liquid egg from one producer.

### SALMONELLA INFECTION IN MANCHESTER AREA 1962

The pattern of infection in the conurbation in 1962 was similar to that elsewhere in the United Kingdom; most of the infection was apparently sporadic. Epidemiological and bacteriological investigations conducted during the year finally revealed that much of this sporadic infection was related to, and emanated from, a single source of unpasteurized liquid English egg.

Seventy-two incidents due to *S. typhi-murium* occurred during the year and twenty-seven of these were found to be due to phage type 4. Incidents due to this type comprised thirty-two cases and twelve symptomless excretors in the conurbation. More than half the clinical cases were in children but only one of the symptomless excretors was a child. No single incident accounted for more than three cases, although one family outbreak included two cases and two symptomless excretors and five symptomless excretors were employees of one infected bakery. The monthly incidence of food poisoning in the south-east Lancashire conurbation in 1962 due to *S. typhi-murium* (all phage types) is illustrated in Fig. 1.

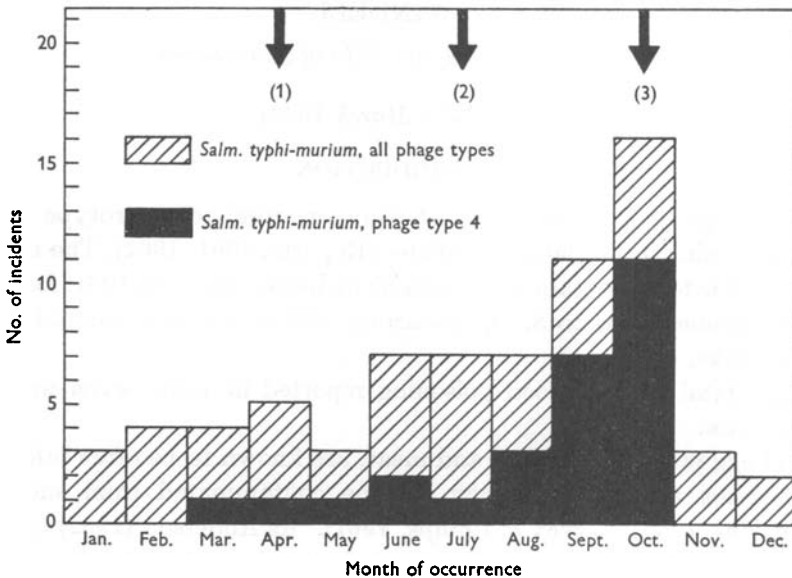


Fig. 1. *S. typhi-murium* food poisoning incidence, south-east Lancashire conurbation, 1962. (1) Producer supplying one bakery. (2) Producer supplying eight bakeries. (3) Producer's liquid egg pasteurized and bakeries disinfected.

Twelve incidents due to phage type 4 embracing fourteen clinical cases and eleven symptomless excretors occurring in the city of Manchester are detailed in Table 1 and were subjected to special study.

#### NOTES ON CLINICAL CASES

In case 1, a Sonne dysentery infection was also reported by the laboratory in addition to *S. typhi-murium*. Case 2 was seriously ill and required intravenous therapy in hospital, while case 4 presented with a scarlatiniform rash. In two cases (5 and 12) a long period of diarrhoea and associated abdominal symptoms preceded the detection of the organism.

Table 1. *City of Manchester. Food poisoning incidents due to Salmonella typhi-murium, phage type 4, 1962*

Incident number	Clinical case or excreter number	Date of onset or laboratory diagnosis	Age	Sex	Source of infecting agent or other relevant information
I	Case 1	4. viii. 62	2 years	M	Unknown
II	Case 2	17. viii. 62	Adult	M	Had meals at establishments, some of which obtained foods from suspect bakeries
III	Case 3	22. viii. 62	Adult	F	Confectionery from bakery using dried egg from infected liquid egg producer
IV	Case 4	6. ix. 62	2 years	F	Unknown
	S.E. 1	17. ix. 62	9 months	F	Sister of case 4
V	Case 5	18. ix. 62	20 months	M	Confectionery from suspect bakery
VI	Case 6	19. ix. 62	5 years	M	Confectionery from suspect bakery
	Case 7	25. ix. 62	6 years	F	Sister of case 6
	S.E. 2	8. ix. 62	Adult	F	Mother of cases 6 and 7
VII	S.E. 3	8. ix. 62	Adult	F	Nurse of cases 6 and 7
	Case 8	28. ix. 62	19 years	F	Ate infected trifle
	Case 9	5. x. 62	Adult	F	Room-mate of case 8
	S.E. 4	11- 15. x. 62	Adult	M	Operative, suspect bakery (A)
	S.E. 5			F	
	S.E. 6			M	
	S.E. 7			M	
S.E. 8	M				
S.E. 9	12. x. 62		F	Resided with symptomless excreter 4	
S.E. 10	22. x. 62		M	Operative, suspect bakery (B)	
VIII	Case 10	1. x. 62	11 years	M	Confectionery from suspect bakery (A)
	S.E. 11	17. x. 62	Adult	F	Grandmother case 10
IX	Case 11	9. x. 62	Adult	M	Had meal at cafe supplied by suspect bakery
X	Case 12	Early x. 62	11 years	M	Confectionery from suspect bakery
XI	Case 13	Mid. x. 62	2 years	M	Confectionery (?) from suspect bakery
XII	Case 14	28. x. 62	Adult	M	Uncertain

## ACCOUNT OF THE INVESTIGATION

A number of scattered and apparently unrelated incidents due to *S. typhi-murium*, type 4, had occurred over several months in the conurbation, but no linking factors between them had been found and the source of infection was unknown.

A young resident (case 8) at a hostel for unmarried mothers, administered by the city, became suddenly ill with pyrexia and diarrhoea two days after dining at a café in the city. Apart from this she had taken all meals with other residents at the hostel, none of whom was indisposed. *S. typhi-murium*, type 4, was isolated from her faeces. A trifle sampled at the café also contained this organism. As a result, the bakery which prepared the trifle was investigated, and *S. typhi-murium* was found in samples of liquid egg and in swabs taken from mixing machines, bowls, whisks and table surfaces. Five symptomless excreters were found amongst twenty-one employees in the bakery. The infected unpasteurized liquid egg used in the bakery, almost certainly the immediate agent of infection, was issued by a firm in the area of a neighbouring authority. Inspectors from this authority found that the producer was distributing unpasteurized liquid egg to a steadily widening field of bakeries in the area. The eggs used were rejects obtained from an egg-collecting station in Yorkshire. These were mostly hen's eggs but also included some duck and turkey eggs. The realization that infection was probably widely scattered through many bakeries in the area called for an investigation of such premises.

All 224 bakehouses in the city were visited to discover what type of egg products were used. Ninety-one of these bakeries used liquid egg, twenty-two dried egg and sixteen fresh egg; the remaining ninety-three did not use egg.

In view of the large number of bakeries concerned, preliminary inquiries were made at the larger establishments first, samples of liquid and dried egg being examined and members of the staff being required to submit faecal specimens. Infection was detected in samples from three moderate-sized bakeries. In one of the bakeries a further symptomless excreter of *S. typhi-murium*, type 4, was detected among seven operatives and he was excluded from work pending the examination of three successive negative faecal specimens over a period of 8 days.

Although conditions at the bakehouses visited were generally satisfactory, it was evident that, apart from six large bakeries which mainly used pasteurized egg, few proprietors appreciated the potentialities of unpasteurized liquid egg as a cause of food poisoning. They were advised to insist on being supplied in future with pasteurized egg and to take adequate steps to sterilize any equipment liable to contamination.

In order to assess the bacteriological condition of the liquid or frozen bulked egg mainly used at the other smaller bakeries, it was considered more practical to examine samples obtained at the focal points of supply within the city rather than at the bakeries themselves. As this outbreak resulted from home-produced egg, attention was directed to this in the first instance, imported egg being subject to some control at the port of entry.

It was found that an egg producers' marketing organization had stocks of English and imported egg in a city cold store at the disposal of five dealers who supplied fifty-four of the ninety-one bakeries. From the middle of October to the end of December 1962, samples were examined bacteriologically from 272 tins representing a 5% selection of 68 tons (40 batches) of English frozen egg at the cold store. *S. typhi-murium*, phage types 1 var. 5 and 12a, was found in nineteen samples; 7 tons (3 batches) of the egg were therefore detained pending satisfactory arrangements for pasteurization.

This programme of sampling home-produced liquid egg and associated products will be continued until pasteurization becomes a routine measure.

#### *Laboratory investigations*

Swabs taken from the bakery utensils and tables were cultured overnight at 37° C. in selenite F medium. Subcultures were made on to deoxycholate-citrate agar and Wilson and Blair medium and these were then incubated overnight. From each sample of liquid egg 10 ml. were distributed into each of three universal containers. To two of these, 10 ml. double-strength selenite medium were added: one was incubated at 37° C. and the other at 43° C. To the third universal container 10 ml. tetrathionate medium were added followed by incubation at 37° C. Subcultures were made next day on to deoxycholate-citrate agar and Wilson and Blair medium. Colonies suspected of being salmonellae were examined biochemically and serologically. Cultures of *S. typhi-murium* were sent to the Enteric Reference Laboratory, Colindale, for phage-typing.

#### *Pasteurization of liquid egg*

Eggs are broken out, the shell is smelt for soundness and the liquid egg passed or rejected accordingly.

The liquid egg is then bulked and emulsified before heating in a plate exchange apparatus to 60–65° C. The process is thermostatically controlled and the liquid is held at this temperature for 4 min. and then cooled to about 6° C., unless the egg is to be spray-dried, when it is not cooled below 16° C.

After pasteurization the liquid egg is run into sterilized tins which are sealed and refrigerated.

Sampling should be undertaken by the local health authority and the product not released for sale until purity is confirmed.

#### DISCUSSION

The outbreak described here indicates once more that liquid egg is an important source of human infection. This danger has been long recognized (Report, 1955, 1958, 1959). The point that emerges is that much of the illness from this source is sporadic in distribution and its epidemiological significance is easily missed. Anderson (personal communication) states that phage type 4 is commoner in ducks than in hens, and, as it is likely that duck eggs were included in the unpasteurized

eggs responsible for the type 4 infections, it is possible that they were responsible for the introduction of the infecting organism. The importance of looking for environmental contamination where food is produced cannot be over-emphasized.

The producer of this infected liquid egg started in business in April 1962, and at first supplied one bakery. He drew his eggs for breaking from the same source as a pasteurizing plant near Manchester. Liquid egg sampled before pasteurization at this plant in April was shown to be contaminated with *S. typhi-murium*, phage type 4. Thus, by inference, the egg distributed by the producer was contaminated with this organism from the onset. By July he was supplying eight bakeries. From the diagram (Fig. 1) it can be seen that about this time the number of incidents due to type 4 began to increase. When investigated, in October, only three bakeries showed evidence of environmental contamination. These three bakeries used more egg than the others and in each of them some of the staff were found to be excreting the organism. Two of these bakeries were associated with cases of food poisoning in the population. The third bakery produced only bread, using the contaminated egg as a glaze. In this bakery there were no opportunities for cross-infection of other products. When the source of the contaminated egg became known, the producer immediately submitted his product for pasteurization. At this time also, the contaminated bakeries were cleaned and utensils sterilized. After this, no more cases of type 4 infection were notified.

A retrospective survey of earlier incidents of *S. typhi-murium*, type 4, food poisoning was made in Manchester. Of fourteen cases nine were certainly infected via contaminated bakeries and three others probably were. The association was not absolute for two reasons. First, in some instances there was a lapse of 2 months or more before the relevant inquiry was made and, secondly, the producer in question was probably not the only source of type 4 infection in Manchester, as this type had been isolated in previous years.

Unlike the salmonella infection of meat and poultry, the contamination of egg products can be controlled effectively by pasteurization. Efficient methods for this have been developed and standardized (Heller, *et al.* 1962) and plant is becoming available to carry them out. Bacteriological and chemical tests make the control of the product a simple matter.

The pasteurized product is not inferior in baking quality but the opposition to its use amongst bakers questioned in this inquiry appeared to be based on conservatism and ignorance. In fact, many of the bakers had at times, unknown to themselves, been supplied with pasteurized egg which they used without comment. Although the Manchester investigation revealed an imperfect standard of hygiene in certain bakeries, the complete adoption of adequate hygienic measures in bakeries would not alone be sufficient to ensure the safety of the community from food poisoning through the use of unpasteurized egg products. There is little doubt that the use of liquid egg is increasing and it appears essential that no liquid egg should be issued for use in the confectionery or related trades before it has been effectively pasteurized. There are sufficient plants in the country capable of pasteurizing liquid egg and it is hoped that prompt legislation will be introduced so that one more gap in food hygiene is eliminated.



Under the Public Health (Imported Food) Regulations, it is an offence to import any article of food for sale for human consumption which has been examined and not found to be fit. Ross (1962) records that since 1955, 75 salmonella serotypes have been isolated from imported egg products; only 20 of these serotypes have not been associated with human infection. Imported eggs and egg products are covered by these Regulations.

No existing legislation requires the pasteurization or other suitable treatment of home produced eggs and egg products, and only the broad protective measures of the Food and Drugs Act, 1955, exist for dealing with them.

The present investigation taken together with the results of other inquiries, indicates that home-produced liquid egg is often infected with salmonella organisms and emphasizes the need for severe restrictions on the commercial use of unpasteurized liquid egg and associated products. Certainly duck and turkey eggs, more likely to be infected with pathogens, should be excluded from liquid egg. According to Masár (personal communication) duck eggs cannot be used in food intended for human consumption in Czechoslovakia or Russia.

#### SUMMARY

During 1962, twenty-seven food poisoning incidents due to *Salmonella typhi-murium*, phage type 4, comprising thirty-two cases and twelve symptomless excretors, occurred in the south-east Lancashire conurbation. The source of infection was a single small producer of English liquid egg. Pasteurization of the product coincided with the end of the outbreak. The cases were sporadic in distribution. Investigation of previous incidents due to this phage type in the City of Manchester pointed to egg from the same producer. As a result an investigation was made into the amount and source of unpasteurized egg in use in the city. This revealed the frequent presence of salmonella infection and demonstrated the need for pasteurization of liquid egg before use.

We are indebted to Dr E. S. Anderson and the staff of the Enteric Reference Laboratory, Colindale, for phage-typing the strains of *S. typhi-murium*, so essential to this investigation: also to the food inspectors of the City of Manchester and to Mr Hobson, Chief Public Health Inspector, Salford.

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