SALMONELLA FOOD-POISONING

A report of a *Salmonella oranienburg* outbreak in B.A.O.R.

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Introduction

SALMONELLA infections constitute a range of clinical syndromes varying from the severe and fatal forms of typhoid fever to cases of mild abdominal discomfort. Indeed an asymptomatic carrier state may be found.

The commonest form of salmonellosis is gastro-enteritis, often loosely termed food poisoning. Today, due to communal feeding habits, easier travel and international trade in foodstuffs for human and animal consumption, the incidence of these infections has increased on a world-wide scale, so that salmonellosis presents a serious public health problem.

The Salmonella organisms are common intestinal pathogens of a wide variety of animal meat sources such as pigs, cattle, chickens, hens, turkeys and ducks. Infection may result directly from an infected animal carcass or products derived from an infected animal; or indirectly when food is contaminated by an extraneous source which may be a human carrier or the excreta of animals.

The different salmonella types are distinguished mainly from each other by serological typing of their antigenic structure, namely O-somatic, Vi-surface and H-flagellar antigens. Many of these antigens are common to a number of types, and therefore it often requires the resources of a Salmonella Reference Centre to identify with certainty a particular serotype. It is therefore fortunate that workers in Army Laboratories have at the David Bruce Enterobacteriaceae Reference Laboratory their own facilities for full investigation of salmonella types, and in addition a source of supply of excellent typing sera for preliminary identification tests.

On studying the antigenic structure of salmonella serotypes in different parts of the world, it is seen that certain types predominate in any particular geographic area. This is borne out by the number of ' foreign ' types isolated in UK. To illustrate this finding, two contrasting examples may be given. (See Table I).

Table I
Showing Incidence of Salm. Oranienburg and Salm. Thompson isolated from Cases or Outbreaks of Food Poisoning in England and Wales.

Years	:	1923 – 39	1940	41	42	43	44	1954 – 1956
Salm. oranienburg	:	0	0	0	10	30	36	41
Salm. thompson	:	49	19	20	9	19	20	330

(1) *S. oranienburg* is a very common pathogen of chickens and hens in the USA. It was in the past completely unimportant in Great Britain but during the last

war cases of food poisoning increased considerably in England and Wales, and during 1942/44 of the hitherto unreported salmonella serotypes isolated from cases or outbreaks of food poisoning, *S. oranienburg* was the commonest. This was attributed to the consumption of spray-dried egg imported from America, ten per cent of which when tested were found to be contaminated with salmonellae.

(2) *S. thompson*, on the other hand, was the third commonest salmonella causing food poisoning in UK before the last war. During the war years its incidence declined but afterwards it resumed its previous importance, so that by 1954-1955 it ranked second only to *S. typhimurium* as a cause of salmonella food poisoning. The source of *S. thompson* remained unsuspected until it was discovered that the organism represented the predominant salmonella in imported Chinese eggs. During the war of course trade with Cihna had been suspended, while over 200,000 tons of dried eggs were imported from America (Mth. Bull. Minist. Hlth. Lab. Ser., 1958).

Considering the numerous habitats of *Salmonella*, it is amazing that salmonellosis is not even commoner than it is at present. On investigation of these pathogenic organisms various host-parasite factors came into play which will determine the outcome of the infection. For instance, experiments investigating human salmonellosis, carried out by McCulloch and Eisele (1951), who fed graded dose of different types of salmonellae and different strains of the same salmonella type to volunteers in a penal institution, showed the great variation of dosage that is required to produce clinical illness. Thus using different strains of *S. meleagridis* as the infecting organism in graded doses, one volunteer was infected with 7.7 million organisms by one strain, while a different strain of the same organism failed to produce illness in 4 out of 5 volunteers at a dose of 24 million organisms. The variation in dosage was even more marked using *S. anatum;* in this experiment one strain produced clinical illness in 3 out of 6 volunteers at a dose of 860,000 organisms, while a dose of 67 million bacilli of another strain was needed to produce the same morbidity, 4 out of 8. Age is also an important factor when the outcome of Salmonella food-poisoning infection is considered; the extremes of age suffer most fatalities. Thus for the last two years for which figures are available, twenty fatal cases due to Salmonella food poisoning were recorded in each year in the UK; the age distribution is shown in Table II.

Table II
Showing Age Distribution of fatal Cases of Salmonella Food Poisoning reported in 1961–1962.

	1961	1962
Less than a year	3	2
1 – 9 years	3	1
10 – 59 years	2	1
60 – 69 years	4	5
70 or more	2	6
Not precisely stated	6	5
TOTAL	20	20

Description of Salmonella Oranienburg Outbreak

On the morning of the 14th May, 1964, about 300 meals were prepared in the other ranks kitchen of a unit stationed in Osnabruck, B.A.O.R., and served for consumption at a fete in the unit's lines.

The meal consisted principally of a salad, lettuce, cucumber, tomatoes, potatoe salad, salad cream, chicken, ham, spam, hot dogs, sausage rolls, ice cream and tinned peaches. All the foodstuff was stated to have been obtained from the local NAAFI shop that morning.

Within 24 hours an epidemic of 'classical' *Salmonella* gastro-enteritis broke out in the unit. The main clinical symptom was diarrhoea (accompanied by pyrexia, shivering, vomiting). The first patient reporting ill was referred to the nearest military hospital as possibly suffering from acute appendicitis, but almost immediately after the first patient, others reported sick to a total of 39.

The severer cases were treated in the M.R.S., while the milder cases were treated as out patients. Initially treatment was started with sulphonamides and kaolin, but later tetracyclines were substituted in accordance with the drug sensitivity pattern of the isolated *Salmonella*.

The actual food left over having by then been discarded, attention was therefore directed to supervision of kitchen hygiene and screening of food handlers. Of thirty Service cooks or food handlers, fifteen were found to be infected, six showing clinical signs of infection and the remaining eight being symptomless excreters. Twenty-one civilian food handlers were screened, and nine were found to be infected, of whom only one showed clinical signs of infection.

Bacteriology: Materials and Methods

At the beginning of the outbreak routine bacteriological tests for the investigation of a food poisoning outbreak suggestive of salmonellosis, were instituted (Taylor, 1951; Mackie and McCartney, 1962). Faeces were inoculated on to McConkey's and desoxycholate-citrate agar, and selenite ' F ' enrichment medium.

During the latter part of the investigation, i.e. when clearance tests on specimens from treated personnel were being done, the standard laboratory procedures were modified considerably with great saving of effort, materials and incubator space. Specimens of urine and faeces were inoculated into selenite ' F ' liquid medium; after overnight culture and again after 72 hours incubation, a loopful of medium was taken up and spread on a desoxycholate-citrate solid medium. Subsequently at least three pale colonies were carefully selected and inoculated into the following set of four bottles, containing respectively:-

1. Christensen's urease medium (to eliminate Proteus species).
2. Peptone-Water compound sugar medium containing 0.6 per cent lactose, sucrose, salicin and adonitol. (Fermentation of these substances practically rules out Salmonellae).
3. Peptone-Water compound sugar medium containing 0.6 per cent glucose and mannitol. (Salmonella produce acid and gas from both these substances).
4. Nutrient agar slope for serological typing of culture.

Only three diagnostic sera were needed in these clearance tests, namely:

' O ' factors 6,7

' H ' factors m,t

and one other serum with no relation to *S. oranienburg*, which was used as a

negative control to guard against non-specific agglutination.

The drug sensivity pattern of the isolated organism showed that it was very sensitive to chloramphenicol and the tetracyclines, less sensitive to neomycin, and only feebly sensitive to penbritin (Ampicillin).

The Officer Commanding, the David Bruce Laboratories has supplied the following detailed report on the characteristics of the salmonella type isolated in the outbreak reported in this paper:-

Lactose	—	Negative (7 days)	Sorbitol	—	Acid and gas
Glucose	—	Acid and gas	Indole	—	Negative
Mannite	—	Acid and gas	Urea	—	Nil
Dulcite	—	Acid and gas	Koser's Citrate	—	Nil
Saccharose	—	Negative (7 days)	M.R.	—	Positive
Salicin	—	Negative (7 days)	V.P.	—	Negative
			H_2S	—	Positive

The antigenic structure, using multi and single factor sera to titre, was shown to be:- 6,7:m,t:- corresponding to *S. oranienburg*.

Discussion and Comments

In dealing with outbreaks of salmonellosis, prompt action is required by medical officers in medical care or units, and imaginative and diligent efforts to obtain material for laboratory examination should be immediately instituted, *immediately* being the operative word. (War Office—Manual of Army Health, 1959).

Salmonella bacilli are quite easy to isolate from suspect material and present no great problem with present laboratory cultural methods and media; nevertheless considerable difficulties will be encountered in actual practice in the field.

(1) Inspection of food, before it is consumed, may give no safeguard against eventual infection. Food infected with *Salmonella* organisms has usually a wholesome appearance (Jameson and Parkinson, 1958).

(2) By the time the bacteriologist arrives on the scene, or the medical officer has fully realised that he has to deal with a salmonella outbreak, the article of food which may later come to be strongly suspected, as often as not, will have been thrown away and the food container, if any, most probably lying buried under tons of debris at the nearest refuse dump. In this outbreak all the foodstuffs had already been discarded by the time investigations began.

It is suggested that in Army Depots, establishments and institutions under Army medical supervision, it would prove both useful and practicable as some civilian health authorities have found to have specimens of each meal, as prepared and issued by the kitchen staff, stored in a deep freeze refrigerator for 24-72 hours. This would appear to be highly desirable in Army schools and particularly in hospitals because salmonellosis there would result in dire consequences to patients and to the newly born in maternity wings.

(3) There may be a remarkably uneven distribution of infection in the suspected article of food, as is often illustrated by the failure to isolate the incriminated salmonella serotype from other samples of the same batch of food that may have been the cause of a particular outbreak under investigation.

Table III shows the distinguishing features of *Salmonella* gastro-enteritis as com-

Table III
Useful Diagnostic Pointers in Food Poisoning Outbreaks.

	BACTERIAL				CHEMICAL	
Onset	0–6 hrs.	6–24 hrs.	6–24 hrs.	12–36 hrs.	Varies	Varies
Symptoms (1)	Vomiting	Diarrhoea	Diarrhoea	Constipation	Vary	Vary
(2)	Nausea and Prostration	Fever and Vomiting	Nausea and Prostration	Central Nervous System affected	Vary	Vary
(3)	Diarrhoea	Abdominal Pain			Vary	Vary
Source	Processed meat products Milk and products. Skin infections of food handler	Meat and products. Milk and products. Egg and products Fish. Human carrier	Meat and meat dishes. Soups, stews, gravies.	Preserved meat products. Sausages. Home canned vegetables. (Can often " Blown ")	Fungi—eg Amanita phalloides) Fish—eg Moray eel) Plants—eg Deadly Nightshade)	Heavy metals (Zinc from containers, lead from solder, antimony from enamel-ware, etc.
Cause	Staphylococcus	Salmonella	Clostridium Welchii	Clostridium Botulinum	Inherent in article of food consumed.	Contaminant

pared with other agents causing food poisoning. The table has been over-simplified, in order to make it more useful for easy reference. Nowadays it is realised that besides the bacterial organisms listed in Table III, there are a number of other organisms which, if present in sufficient numbers, will cause symptoms of food poisoning; these include *Proteus*, *Streptococcus*, *Escherichia coli*, *Paracolon bacilli*, *Aerobacter aerogenes* and others. Every year a number of outbreaks are reported, where no known food poisoning organism is found and therefore there may be other organisms (not necessarily bacterial) which may produce gastro-enteritis (Mth. Bull. Minist. Hlth. Lab. Ser, 1957).

S. oranienburg was first isolated in 1930 from the stools of an apparently normal boy in an orphanage in the German town of Oranienburg, in which an outbreak of diarrhoea had occurred (Kauffmann, 1930). As mentioned earlier, this organism was the commonest *Salmonella* present during the last war in imported dried egg from the USA where it was first demonstrated by isolation from an outbreak affecting baby quail (Edwards, 1936).

Taylor (1947), reporting the clinical features caused by 91 strains of *S. oranienburg* isolated from epidemic outbreaks or sporadic cases, stated that the clinical picture was usually that of gastro-enteritis with diarrhoea and abdominal pain as the universal symptoms, but added the observation that '*S. oranienburg* may cause human disease with different clinical pictures'. One clinical history given was that of an Army cook who was stricken down suddenly and acutely at 2 a.m. complaining of abdominal cramps, nausea, vomit and diarrhoea while another female patient showed pyrexia as the one and only symptom. Cases of localisation of the organism in many tissues of the body producing abscesses, as in any blood-borne infection, have also been reported.

Summary

1. Salmonella food poisoning presents a serious public health problem due to presence of *Salmonella* types in numerous animals, the free movement of people between countries and continents and the great international trade in foodstuffs for human and for animal consumption.
2. The clinical effects of salmonellosis depend on a balance of factors between host and parasite, for instance the strain of the salmonella serotype, the infective dose ingested, and the age of the affected person are very relevant. Useful differential diagnostic points in food poisoning incidents are given in a tabulated form.
3. A recent outbreak of food poisoning caused by *S. oranienburg* in a B.A.O.R. unit, is described to illustrate features of a typical Salmonella incident. Details of the laboratory procedures used in this type of investigation with some time and labour-saving personal modifications are given.
4. Attention is drawn to the need of prompt and co-ordinated action by a team (clinician, bacteriologist, hygienist) in cases of food poisoning outbreaks; the difficulties of investigation likely to be met with in actual practice are noted. It is suggested that in Army Establishments specimens of each meal should be preserved for 48-72 hours, in order to help subsequent investigations should any food poisoning incidents occur.

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