ENTERIC FEVERS AND NORMAL SALMONELLA AGGLUTININS IN THE GOLD COAST

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I. INTRODUCTION

For many years clinicians have recognized that enteric fevers are endemic in the Gold Coast. A similar situation has been reported in Sierra Leone by Reid (1953). McLetchie (1954), however, deduced from statistical returns that 'enteric infections do not appear to be a major problem in Nigeria'. Apart from Reid's paper there is little published information available concerning the status of the enteric fevers in West Africa, and it has therefore been thought desirable to report the information gathered in Accra during the $2\frac{1}{2}$ years between October 1952 and March 1955.

Over the past 25 years there has been a gradual increase in the actual numbers of enteric fever cases diagnosed annually in the Gold Coast. There has also been a rise in the proportion of enteric fever cases among the ever-increasing number of patients treated in government hospitals and dispensaries. There has, also, been a tenfold increase in the number of cases diagnosed bacteriologically each year, not all of which is attributable to improvements in media and technique. There is thus a strong probability, falling short of statistical proof, that enteric infections are now more prevalent in the Gold Coast than they were 25 years ago.

As long ago as 1937 Duff noted the sanitary deterioration of the Gold Coast capital, Accra, and forecast an increase of enteric fevers. He would appear to have been right, and since that date there has been considerable growth throughout the colony of towns where the sanitary organization leaves much to be desired. In the older centres too the sanitary services have failed to expand at the same rate as the towns themselves. The growing importance of enteric fevers in the Gold Coast renders it desirable to consider the bases of diagnosis in that country, and to summarize what is known of the laboratory aspects of these diseases in West Africa.

II. AGE DISTRIBUTION OF ENTERIC FEVER PATIENTS

During $2\frac{1}{2}$ years enteric organisms were isolated from 324 patients, but in only 253 cases was the age of the patient recorded. The age distribution of these 253 patients with proved enteric fever is shown in Table 1.

It is interesting to compare the age distribution of typhoid fever patients in the Gold Coast with that quoted by Goodall (1928) from the Metropolitan Asylums Board's statistics for London, and also with the figures quoted from Godfrey by Wilson & Miles (1946) for New York, at periods when typhoid fever was still prevalent in those cities. This comparison is made in Table 2.

Table 1. *Age incidence of enteric fever in 253 Gold Coast patients*

Age group (years)	Typhoid		Paratyphoid A		Paratyphoid C		All enteric fevers	
	No. of cases	% of total	No. of cases	% of total	No. of cases	% of total	No. of cases	% of total
Under 5	15	7·4	5	14·3	8	41·2	28	11·1
5–9	36	17·7	2	6·3	7	36·8	45	17·8
10–14	30	14·8	2	6·3	0	—	32	12·7
15–19	28	13·8	1	3·1	0	—	29	11·5
20–24	35	17·2	6(+1)*	21·9	2(+1)†	15·8	43	16·6
25–29	31	15·3	5(+2)*	21·9	0	—	36	14·3
30–34	9	4·4	6	18·7	0	—	15	5·9
35–39	6	3·0	3	9·3	0	—	9	3·6
40–44	6	3·0	1	3·1	1	5·3	8	3·3
45–49	0	—	1	3·1	0	—	1	0·4
50 and over	7	3·4	0	—	0	—	7	2·8
Totals	203	100·0	32(+3)	100·0	18(+1)	100·0	253	100·0

* Three double infections typhoid-paratyphoid A, counted as typhoid.
† One double infection typhoid-paratyphoid C, counted as typhoid.

Table 2. *Incidence of typhoid fever at ages in the Gold Coast, London and New York*

Age groups (years)	Percentage of all cases occurring in each age group		
	Gold Coast 1952–5	London, 1871–1914. After Goodall (1928), quoted from M.A.B. reports	New York, after Godfrey, quoted by Wilson & Miles (1946)
Under 5	7·4	3·7	4·5
5–9	17·7	12·8	13·8
10–14	14·8	20·0	14·3
15–19	13·8	18·6	14·2
20–24	17·2	14·9	12·0
25–29	15·3	11·8	9·7
30–34	4·4	7·5	7·7
35–39	3·0	5·0	6·3
40–44	3·0	2·8	5·4
45–49	—	1·6	3·9
50 and over	3·4	1·3	8·2

It will be seen from Table 2 that the greatest numbers of typhoid patients in London and New York were in the second decade of life, whereas in the Gold Coast the highest figures were in the first decade and the third. This may be interpreted as indicating that in the Gold Coast typhoid fever is of particular importance among children, and also among the vulnerable migrant labourers whose poor diet and way of life render them fertile soil for enteric infections. This conclusion must be treated with reserve, however, because these two groups of high enteric incidence are also the most numerous age groups in the population of Accra whence came most of the cases of enteric fever.

There are no accurate statistics of mortality in the different age groups in the Gold Coast. Colbourne & Edington (1954) have analysed for another purpose the causes of death in the post-mortem records accumulated by numerous pathologists at the Medical Research Institute, Accra, during a period of 31 years: the figures in Table 3 of their paper show that enteric fever was the cause of death in 4·9 % of 426 children under 6 years of age, in 10·4 % of 191 between the ages of 6 and 15 years, and in 2·8 % of 2539 persons of 16 years of age and over. These figures, for what they are worth, support the conclusion that enteric fevers are particularly important among children in the Gold Coast.

III. SEX INCIDENCE OF ENTERIC FEVERS

The sex of the patient was recorded in 292 bacteriologically proved cases of enteric fever. One hundred and sixty of these patients were men and 132 women, a male to female ratio of 1·21 to 1. The male group is probably weighted by the migrant labourers, and by the fact that men attend hospital more often than women in the Gold Coast. The ratio of males to females attending all government hospitals and dispensaries in 1952 was 1·37 to 1 (Report, 1954). In the Gold Coast enteric fevers probably attack both sexes equally.

IV. DIAGNOSIS OF ENTERIC FEVERS

As long as the treatment of enteric fevers remained purely symptomatic it was possible to make repeated attempts at serological and bacteriological diagnosis without reference to the time factor. The advent of specific antibiotic therapy has entirely changed the outlook, and clinicians now not only require a diagnosis at the earliest possible moment, but may have to begin antibiotic treatment without waiting for the necessarily slow procedures involved in isolation and identification of the causative bacteria. The bacteriologist is now in the position, in many cases, of having to make a diagnosis on specimens collected on the first day upon which enteric fever is suspected clinically. After antibiotics have been administered the isolation of the causative organism becomes infinitely more difficult, whilst rising serum agglutinin titres are of retrospective interest only, and may also be affected by successful treatment.

As well as the leucocyte count, which can be classed as a useful clinical guide, there are three important laboratory procedures which should be undertaken in every case as soon as enteric fever is suspected, namely culture of clotted and whole blood, culture of faeces and the Widal test. Culture of the urine is less important, but in a country where bilharzia is endemic haematuria from this cause may give rise to enteric bacilluria at a relatively early stage of the disease. For this reason urine culture should be done whenever possible as one of the less important aids to early diagnosis.

Table 3 shows the results of the major diagnostic procedures in 100 consecutive cases of typhoid fever in which all three tests were made within 48 hr. of the diagnosis being considered.

It will be seen from Table 3 that the immediate laboratory diagnosis would have been missed in twenty-one cases if the blood (including blood clot in some cases) had not been cultured, and in seven cases if faecal culture had been omitted. In sixteen cases a presumptive early diagnosis was made on the Widal test alone (confirmed later by rising titres), and the diagnosis would have been missed had this test not been done.

Table 3. *Relative importance of blood culture, faecal culture and Widal test in early diagnosis of* 100 *consecutive cases of typhoid fever*

Results of tests			Number of cases
Blood culture	Faecal culture	Widal	
+	+	+	15
−	+	+	11
−	−	+	16
+	−	+	22
+	+	−	4
+	−	−	21
−	+	−	7
−	−	−	4*

* The diagnosis in four cases was established later by blood culture (one case), urine culture (one case), and by rising agglutinin titres (all four cases).

Blood cultures were done by the Castaneda technique, and occasionally gave a positive result within 24 hr. With a few such exceptions, however, culture results were not available earlier than 2 or 3 days after collection of the specimen. The result of the Widal test, on the contrary, was always ready within 24 hr. and in sixty-four cases it was positive in the first specimen and provided laboratory grounds for beginning treatment at once.

The information contained in Table 3 probably reflects local conditions in the Gold Coast, for 80 % positive cultures at the first attempt is less than would be expected from early enteric cases in Europe. African patients often neglect to consult a doctor during the first few days of any illness; febrile patients of all races in the Gold Coast are usually treated, or treat themselves, with antimalarial drugs for the first 2 or 3 days of their illness, and in many cases enteric fever is only suspected when antimalarial treatment has failed to produce defervescence. It is not unlikely that a substantial proportion of patients in whom laboratory diagnosis is attempted have at least entered the second week of their enteric fever.

During the period under review the Widal test had not been fully standardized in relation to standard sera, the titres regarded as significant being determined as a result of experience, and in the light of an agglutinin survey performed by the same unstandardized method. Standard sera have since become available and the actual titres observed in the diagnostic tests mentioned in Table 3 are thus of no interest, and therefore will not be recorded here.

V. BACTERIOLOGY OF ENTERIC FEVERS IN THE GOLD COAST

The organisms isolated from 324 cases of proved enteric fever during 2½ years are detailed in Table 4.

Table 4. *Organisms isolated from* 324 *patients with enteric fever in the Gold Coast, between October* 1952 *and March* 1955

Organism	Number of cases: Africans	Number of cases: Non-Africans	Number of cases: All races	Total of each type	Percentage frequency of each type
Salm. typhi	235	5	240	245	74·5
+*paratyphi A.**	1	2	3	.	.
+*paratyphi C.**	1	.	1	.	.
+*dublin**	1	.	1	.	.
Salm. paratyphi A	33	9	42	45	13·7
Salm. paratyphi C	25	1	26	27	8·2
Salm. dublin	6	.	6	7	2·1
Salm. cholerae-suis	3	.	3	3	0·9
Salm. eastbourne	.	1	1	1	0·3
Salm. senftenberg var. *newcastle*	1	.	1	1	0·3
Totals	306 (94·5 %)	18 (5·5 %)	324	329	100·0

* Double infections.

Salmonella typhi

The absence of any system for tracing the contacts of typhoid patients makes phage typing a superfluous exercise in the Gold Coast at the present time, and it has not yet been attempted. For similar reasons no attention has been paid to complete biochemical typing. It has been noticed, however, that many strains of both *Salm. typhi* and *Salm. paratyphi A* which have been encountered in Accra have produced H_2S late or not at all; this fact renders the recognition of colonies on bismuth sulphite agar very difficult, and although such media are considered essential for the detection of *Salm. typhi* in Britain their use has been abandoned in Accra.

Two cases of typhoid were encountered which presented as cases of meningitis, and in both cases *Salm. typhi* was isolated from the cerebrospinal fluid. One patient died, but the other made a good recovery after chloramphenicol treatment.

Salm. paratyphi A

This organism has often proved difficult to isolate, and it may therefore be somewhat more frequent than is indicated by the figures in Table 4.

In three cases double infection was proved by the isolation of both *Salm. typhi* and *Salm. paratyphi A* from the same patient; this combination was suspected in several other cases in which the cultures yielded one organism but serum agglutinins suggested that the other was also present.

Most of the strains of *Salm. paratyphi A* encountered in Accra were noticed to produce gas only in small amount after several days incubation. A few strains were anaerogenic. For the early biochemical separation of *Salm. paratyphi A* from *Salm. typhi* it was found useful to include xylose among the routine 'sugar' media, for xylose-negative strains of *Salm. typhi* were not met with very often.

In one case *Salm. paratyphi A* was recovered from a thoracic empyema.

Salm. paratyphi A was involved in eleven out of eighteen cases of bacteriologically proved enteric fever that occurred in non-Africans. Several of the African cases occurred in patients of the professional and wealthier classes who have to some extent adopted European domestic habits. It seems likely that there was, and is, intermittent contamination of some article of food or drink consumed by Europeans and upper-class Africans, probably by an undetected carrier.

Salm. paratyphi B

This organism has only once been isolated in the Gold Coast, by Robinson (1934). The reason for its rarity is obscure for there is a considerable amount of traffic between the Gold Coast and countries where paratyphoid B is endemic.

Salm. paratyphi C

As shown by Table 1 paratyphoid C is mainly a disease of children in the Gold Coast. The disease may be serious in the young. Metastatic pyogenic infections are not uncommon, and de Glanville (1954) recorded from Accra a paratyphoid C abscess associated with an *Onchocerca volvulus* worm. King & Gellatly (1955) have recorded the isolation of *Salm. paratyphi C* in connexion with an epizootic among chickens at a government farm near Accra. The infection was traced to a human carrier.

Salm. dublin

Two arabinose-positive biochemical varieties of this organism have been isolated from man and cattle in Accra (Hughes, 1954). Both varieties cause enteric fever in man, and it seems possible that the arabinose-positive varieties of *Salm. dublin* may be more invasive than the arabinose-negative varieties which commonly give rise to food poisoning in Europe.

Other invasive organisms

An English boy, aged 8 years, had prolonged fever lasting for several months. *Salm. eastbourne* was isolated from his stools on several occasions, and after several negative results his serum showed rising titres of agglutinins against the somatic and specific flagellar antigens of this organism, suggesting that it was indeed responsible for the symptoms.

Salm. cholerae-suis was isolated three times, once from a thoracic empyema, in cases of systemic infection. *Salm. senftenberg* var. *newcastle* was isolated from the faeces of a patient with symptoms of enteric fever.

Three other salmonellae were isolated from the urine of different patients, and it seems likely that they may have reached the urine from the blood stream and that

the patients may have had systemic infections at some previous time. The types concerned were *Salm. ibadan*, *Salm. oranienburg*, and a new type that has occurred twice in Accra, provisionally named *Salm. christiansborg*.

The *chaco* variety of *Salm. enteritidis* was reported by Cosgrove & Reid (1953) to be quite common at Freetown, Sierra Leone, but it has not yet been isolated in the Gold Coast. In Freetown it gives rise to enteric fever.

VI. SALMONELLA AGGLUTININS IN THE SERA OF NORMAL GOLD COAST AFRICANS

The renewed importance of the Widal test, since the introduction of chloramphenicol treatment of enteric fevers, makes it very necessary to standardize the test, and also to discover the normal agglutinin levels in the general population as a guide to the interpretation of agglutinin titres observed in diagnostic tests. The agglutinins found in healthy people also give some idea of the probable frequency of salmonella infections in the community.

For the present survey 200 sera were selected from specimens sent to the laboratory for the Kahn test. Sera were selected which were sufficient in quantity, showed neither haemolysis nor bacterial contamination, and did not come from the Accra lunatic asylum where enteric infections may occur more frequently than elsewhere. Apart from these criteria for selection the sera were those received consecutively of 100 men and 100 women. The serum of one woman was excluded after testing because the agglutinin levels suggested a current attack of enteric fever, and inquiry from the patient's doctor elicited information that suggested that this was a likely diagnosis. No relationship could be detected between a positive Kahn test and the results of salmonella agglutinin titration. The serum samples on which Widal tests were done were not heated before the tests.

Standard agglutinable suspensions from the Standards Laboratory, Colindale, London, were used. These suspensions were well within their expiry dates, and had been stored in the bottom part of a domestic refrigerator since their arrival in the Gold Coast. Through the kindness of Lt.-Col. H. J. Bensted, Director of the Central Public Health Laboratory, Colindale, standard agglutinating sera were made available. These sera had been prepared in rabbits and had been compared with the International Standard sera.

All the tests were put up in 1 ml. volumes, and volumes were measured with grade A pipettes. H agglutinations were done in Dreyer tubes, and were read immediately after immersion of the lower third of the tubes for 2 hr. in a 50° C. water-bath. O agglutinations were done in thin-walled round-bottomed tubes measuring 2 in. by $\frac{1}{2}$ in., and were incubated for 2 hr. in a dry incubator at 37° C. followed by 18 hr. in a refrigerator. All the tests were read with a lens by indirect electric light against a black background. The standard sera, each at its advertised titre, were included in every batch of tests, and the 'standard agglutination' end-points of the test sera were read as the highest dilution at which agglutination occurred to a degree not less than that given by the standard serum at its advertised titre with the appropriate suspension. It was found that the reading of the H agglutinations was

quite clear-cut, but that O agglutination often tailed off beyond 'standard' agglutination more gradually.

The results of these tests are shown in Table 5, together with the frequency of occurrence of the antigens concerned in 380 cases of salmonellosis or enteric fever caused by organisms possessing one or more of these antigens.

Table 5. *Salmonella agglutinins in 'normal' sera of Gold Coast Africans compared with occurrence of corresponding antigens in Gold Coast salmonellae*

Suspensions	Antigens	Numbers of sera agglutinating at each titre: 100 men $\frac{1}{20}$	$\frac{1}{40}$	$\frac{1}{80}$	$\frac{1}{160}$	$\frac{1}{320}$	100 women $\frac{1}{20}$	$\frac{1}{40}$	$\frac{1}{80}$	$\frac{1}{160}$	Total, both sexes + ve at $\frac{1}{20}$	Percentage of sera agglutinating at $\frac{1}{20}$	Frequency of antigens per cent in 380 patients with salmonellosis in the Gold Coast
Salm. typhi O	9, 12	4	2	—	—	—	6	3	—	—	10	5·0	69·5
Salm. typhi H	d	17	11	7	3	1	13	6	3	—	30	15·0	67·1
Salm. paratyphi A O	1, 2, 12	—	—	—	—	—	—	—	—	—	—	—	11·3
Salm. paratyphi A H	a	4	1	1	—	—	1	1	—	—	5	2·5	11·6
Salm. typhimurium O	4, 5, 12	10	4	—	—	—	13	6	2	—	23	11·5	8·4
Salm. paratyphi B H	b	6	1	1	—	—	1	—	—	—	7	3·5	2·1
Salm. paratyphi C O	6, 7	—	—	—	—	—	—	—	—	—	—	—	18·2
Salm. paratyphi C H	c	2	—	—	—	—	1	—	—	—	3	1·5	8·7

DISCUSSION

The data in Tables 1–4 throw some light on the enteric fever problem in the Gold Coast, and on the employment and interpretation of laboratory aids to diagnosis under West African conditions. There can be little doubt that enteric fevers, particularly typhoid fever, are important diseases in the Gold Coast, especially among children, and that the situation gives no cause for complacency on the part of those responsible for public health and environmental hygiene.

The introduction of chloramphenicol treatment has had the effect of restoring to the Widal test the importance it had tended to lose since bacteriological techniques gained efficiency by the introduction of new selective and enrichment media for the isolation of salmonellae. The Widal is almost the only test which gives an answer quickly, but this by no means detracts from the importance of cultures as a means of making a certain, as opposed to a presumptive diagnosis. In fact culture provided the first laboratory confirmation of the clinical diagnosis in one-third of the cases summarized in Table 3, and might be expected to do so in a larger proportion of cases in countries where patients are seen earlier in the course of enteric fevers than they commonly are in the Gold Coast. Probably, if specimens of blood and faeces for culture had been repeated after 24 hr. before beginning treatment on the Widal result, a higher proportion than 80 % of the cases would have been bacteriologically confirmed. In cases where treatment is withheld cultures should be repeated at least every other day. Table 3 only shows the results of the first cultures.

Before Table 5 can be interpreted it is necessary to consider the extent to which Africans in the Gold Coast may have received typhoid-paratyphoid (T.A.B.) vaccination. The only women who have received T.A.B. vaccine are a few hundred nurses, but a considerable number of men have served in the army. The Officer-in-

charge of Records, Gold Coast Regiment, very kindly provided information from which it was possible to calculate that about 65,000 African male civilians in the Gold Coast had served in the army since 1939. The adult male population of the colony may be calculated from the 1948 census figures, adding the estimated annual increase of 1·77 %; this calculation gives the number of adult males in 1955 as 1,300,000. Assuming that everyone who served in the army received T.A.B. vaccine the proportion of adult men likely to have been vaccinated is thus 65,000 out of 1,300,000, or 5 %. It is therefore likely that five of the men, but probably none of the women, whose sera were used for the tests reported in Table 5, had received T.A.B. vaccine.

It is well known that T.A.B. vaccination gives rise to ephemeral O agglutinins and long-lasting H agglutinins. It will be observed that the proportion of men showing H agglutinins against *Salm. typhi*, *Salm. paratyphi A* and *Salm. paratyphi B* exceeds by approximately 5 % the proportion of women showing these agglutinins. This difference is that expected from the calculation of the proportion of men who have experienced the antigens concerned due to vaccination. It is probable that the remaining flagellar agglutinins in both sexes also indicate previous antigenic stimuli in the form of salmonella infections. That this conjecture is likely is shown by the general agreement between the relative frequencies of the different H agglutinins in the sera and the relative frequencies with which the different H antigens occurred in salmonellae isolated from 380 patients with enteric fevers or other salmonelloses. Although paratyphoid B fever is almost unknown in the Gold Coast there are sufficient infections with other salmonellae also possessing flagellar antigen '*b*' to account for the few sera which agglutinated a *Salm. paratyphi B* H suspension. *Salm. johannesburg* and *Salm. ibadan* are examples of such organisms.

If it be accepted that the presence of H agglutinins in the sera of uninoculated people indicates past infection with organisms possessing the corresponding antigens, it may be inferred from Table 5 that one adult in eight in the Gold Coast (12·5 %) has experienced antigen '*d*', almost always during an attack of typhoid fever. It would not be surprising if this were true.

The presence of O agglutinins is of far less certain significance. Table 5 shows no sex difference in their incidence in normal sera, suggesting that T.A.B. vaccination plays no part in their production. It is known that O agglutinins do not persist for very long after removal of the antigenic stimulus which elicited their production, and it is therefore improbable that these antibodies are directly related to previous salmonella infections. The last column in Table 5 shows that whereas agglutinins to *Salm. typhimurium* O were $2\frac{1}{2}$ times as frequent as those to *Salm. typhi* O in the normal sera, the ratio of *Salm typhi* O antigens to *Salm. paratyphi B* O antigens in the salmonellae infecting patients in the Gold Coast was over 8 to 1.

Salm. typhi and *Salm. typhimurium*, of course, share the somatic antigenic component '12' (formerly XII), which is responsible for co-agglutination of both organisms by sera from patients infected with either. Among the 200 normal sera there were thirty-two which agglutinated either the *Salm. typhi* or the *Salm. typhimurium* O suspensions, but only two of these sera showed co-agglutination of both suspensions. In only five of the thirty-two sera were H agglutinins present

for any of the four H antigens used in the tests. The facts confirm the improbability that persistent salmonella O agglutinins in the sera of healthy people are related to previous salmonella infections. This conclusion is not new, and was reached on slightly different grounds by Gregory & Atkinson (1938), and also by Cruickshank (1939).

'Normal' salmonella agglutinins in the sera of healthy people are useful for the interpretation of the Widal test in any given locality, although the stage of the disease, and the patient's history and clinical condition, must influence the significance to be attached to the results obtained in each individual case. A combination of O and H agglutinations is always of more significance than agglutination of one phase only.

Considering the agglutination of a single suspension only, there is some significance to be attached to the mere presence of agglutinins, irrespective of titre. For example *Salm. typhi* H agglutinins were present in 15 % of normal Gold Coast sera, and no significance can thus be attached to their presence alone; *Salm. paratyphi C* H agglutinins, by contrast, were only found in 1·5 % of normal sera, and their occurrence by chance in a case of undiagnosed fever is improbable, the odds being 66 to 1 against the agglutinins being 'normal', and in favour of their origin from a current infection with an organism possessing flagellar antigen '*c*'.

For a decision on the question of significant agglutinin titres against organisms for which 'normal' agglutinins are common, it is necessary to use positive normal sera only as a basis for calculation. For example, three out of thirty normal sera which agglutinated a *Salm. typhi* H suspension did so at a titre of 1/160. The chances of such a titre indicating current infection are therefore 9 to 1 should the patient happen to be among the 15 % of the population with normal agglutinins for *Salm. typhi* H.

Taking these factors into consideration it is considered that in Gold Coast Africans the lowest significant titre for *Salm. typhi* H agglutination is 1 in 320. Against *Salm. typhi* O or *Salm. typhimurium* O suspensions an agglutinin titre of 1 in 80 probably indicates infection with an organism belonging to salmonella O groups B or D. There are insufficient data for evaluating titres of agglutinins against the other suspensions used, but the rarity of these agglutinins makes their presence at any titre of possible significance.

SUMMARY

Enteric fevers are common in the Gold Coast, where their incidence is increasing owing to insanitary urbanization. Children and migrant labourers form the bulk of the patients. Typhoid fever accounts for three-quarters of the cases, but paratyphoid A and paratyphoid C also occur. The Widal test has attained renewed importance in early diagnosis since the introduction of chloramphenicol, and gave a presumptive diagnosis within 24 hr. in two-thirds of the cases. 'Normal' agglutinin levels were determined in 200 sera sent for the Kahn test, and provide data for interpreting the Widal test in the Gold Coast. Low titre H agglutinins in the sera of normal people are thought to indicate past vaccination or infection, but low titre O agglutinins are probably unrelated to either. Agglutination of a *Salm. typhi* H

suspension by normal sera suggests that one adult African in eight in the Gold Coast has suffered from typhoid fever.

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