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The microbiological and epidemiological properties of infections caused by *Salmonella enteritidis*

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In recent years in many countries, in contrast to the decreasing incidence of typhoid and paratyphoid fevers, there has been a considerable rise in the number of infections caused by other types of *Salmonella* (Brodhage, 1963; Mihalyfi, Kende, Jonas & Vamos, 1961; Galton, Steel & Newell, 1964; Peluffo, 1964; Seeliger & Maya, 1964; Silberstein & Gerichter, 1964; Stahn, 1963). In Poland in 1957 infections with salmonellas, excluding *S. typhi* and *S. paratyphi A* and *B*, were found in 994 sick and 780 healthy persons, and the corresponding figures for 1963 are 3047 and 2369 respectively (Buczowski, unpublished data). In 1964 the number of cases of salmonellosis increased still more. Though in previous years the dominant type was *S. typhimurium* (65–75 % of the total) from 1963 *S. enteritidis* infections were the most frequent. Most of these infections were in infants, and occurred in the form of more or less intensive hospital epidemics.

Since there have been very few reports of infections with *S. enteritidis* (Crainz, Lombardo & Romagnoli, 1960; Kanski, Moszkowska & Skunska, 1947; Nowgorodzkaja, 1957; Swicowa, Kulczynska & Prus, 1962) it appears useful to present observations on certain microbiological and epidemiological properties of these infections.

DESCRIPTION OF THE EPIDEMIC

Up to 1964, *S. enteritidis* was very rarely found in the area investigated. Of a total of more than 3300 cultures of *Salmonella* isolated in the years 1957–63, only three were identified as *S. enteritidis*. The first cases in the epidemic were diagnosed in June 1964, and up to February 1965 there was a total of 309 cases registered* (Fig. 1). In reality the epidemic had probably begun 3–4 months earlier, but unfortunately the disease at this time was treated as a 'virus infection'. Of the total number of cases observed, 293 were discovered among children treated for various reasons in six hospital wards, the remainder were in out-patients or among healthy persons (Table 1). The infection rate with *S. enteritidis* varied from 12 to 70 % of the patients in the affected wards. The hygienic conditions varied from ward to ward, but no strict correlation could be found between these conditions

* At the time when this paper was submitted for publication the number of registered cases had increased to 494.

and the incidence of infection. It was established that the epidemic began in the neonatal ward in the hospital at Lukow, and spread thence by infected children to the infectious and children's wards of the same hospital, and from there to the children's wards of hospitals in Lublin and Radzyn.† The age distribution of cases was from 2 days to 65 years, almost half were children under 6 months (Table 2).

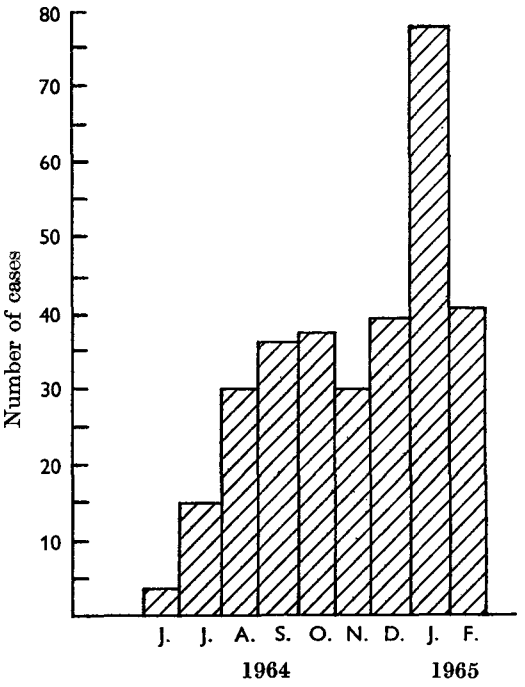

Fig. 1. The epidemic of Salmonellosis in the Lublin province (June 1964–February 1965).

Among hospital personnel eleven cases were noted, but investigations among them were not carried out regularly. It was noted that as the epidemic continued and spread, the number of sporadic cases, not connected with hospital foci, also grew. It is at present difficult to say whether the infection is getting the characteristics of endemicity.

In clinical investigations it was possible to differentiate four forms: gastro-enteritis, 57 % of the total; paratyphoid-like, 5 %; cases with predominant symptoms in the upper respiratory tract, 31 %; inapparent infections, 7 %. In the young the disease was usually severe, the death-rate in the newborn being as high as 25 %, in infants 6–8 %. In older patients the infection usually took the form of slight enteric disorders, or inapparent infection.

† More detailed data concerning these foci are presented in our paper to be published in *Revue Hyg. Méd. soc.*

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Table 1. *Cases of* Salmonella enteritidis *infection detected among patients in particular hospital wards, and other persons*

(1) Hospital of the Lukow region		
Neonatal department	42	
Infants' department	83	
Infectious-diseases department	59	
Total		184
(2) Children's Hospital of the Lublin Medical Academy		
Infants' department no. 5	57	
Infants' department no. 4	8	
Other wards	2	
Total		67
(3) Hospital of the Radzyn region		
Children's department		42
(4) Sporadic cases not directly connected with hospital foci		16
Total cases		309

MATERIALS AND METHODS

A total of 309 cases of infection were examined microbiologically. Altogether 4075 samples were tested, of which 2003 were samples of faeces from 303 persons, 1024 were samples of urine from 203 persons, 328 were blood samples from 145 persons, 442 were swabs from the upper respiratory tract in 131 persons and 278 were blood samples from 139 persons, for serological examination. The investigations of faeces, urine, blood and swabs from the respiratory tract were made according to the methods generally accepted in Poland, using liquid selective-enrichment media. Sera were tested for agglutinins against *S. typhi*, *S. paratyphi A* and *B* and organisms containing gm antigen. In the wards affected by the epidemic, twenty-five air-samples were also taken, by means of bacteriological filters in a 'Staplex' type respirator. Aspiration of the air was made at a height of 1·5 m. and at a distance of 1–3 m. from the beds of the infected babies. In every case we carried out an epidemiological interview to attempt to discover the source and mode of infection, and 346 members of patients' families had their faeces examined 1–3 times.

RESULTS

From samples of blood, faeces, urine and mucus from the upper respiratory tract 1608 cultures of *S. enteritidis* were obtained. The distribution of these positive cultures is shown in Table 3, where it is seen that only 7 out of 303 patients did not show at least one positive culture from the faeces. More than 70% were persistent faecal excreters, and the remainder were intermittent excreters with negative periods of from 10 to 20 days. More than 50% of the positive faecal cultures were from normal stools, but the frequency of isolation of salmonellas from loose stools containing mucus or blood was significantly higher than that from normal stools.

The number of urinary excretors was very high—138 out of 203 investigated

Table 2. *Distribution of* Salmonella enteritidis *cases according to sex and age*

	Age										
	2–14 days	15–30 days	31–60 days	61–90 days	4–6 months	7–12 months	1–3 years	4–6 years	7–14 years	Over 14 years	Total
Male	11	7	15	15	30	26	21	10	22	8	165
Female	9	5	19	19	23	11	23	8	13	14	144
Total	20	12	34	34	53	37	44	18	35	22*	309
%	10·4		22·0		17·1	12·0	14·2	17·1		7·2	100·0

* Eleven were hospital staff.

Table 3. *Results of bacteriological examination of* 309 Salmonella enteritidis *patients*

Investigated materials	Number of patients			Number of positive findings		Distribution of patients according to number of positive findings							
	Investigated	With positive findings	%	Total	Average per patient	1	2–3	4–5	6–7	8–9	10–14	15–19	20–39
Faeces	303	296	97·7	1090	3·7	92	83	64	28	12	12	5	0
Urine	203	138	68·0	377	2·7	49	59	17	11	2	2	0	0
Blood	145	25	17·2	26	1·0	24	1	0	0	0	0	0	0
Respiratory tract	131	37	27·5	115	3·0	16	9	4	4	2	2	0	0
Total	309	309	100·0	1608	5·2	83	80	43	37	23	20	8	15

Of these, 63 were males and 75 females. All specimens of urine from females were collected with a catheter. Urinary excretion usually began much later in the disease than faecal excretion, sometimes as much as 15–25 days after the onset of infection. It was usually persistent, but small numbers of patients showed negative intervals of from 20 to 60 days. Of the positive urine cultures, 16 % were taken from patients with fever, in the acute stage of their illness, and 84 % during afebrile periods.

S. enteritidis was cultured from the blood of 25 infected persons, on two occasions from one of them. Of the 26 cultures, 23 grew within 24 hr. in the incubator, suggesting a relatively heavy blood infection: the other three strains grew after 3–5 days incubation. The clinical course of the disease in children with bacteraemia was usually severe, and 25 % of them died. It is noteworthy that the blood culture was positive in only 18 of 83 urinary excreters whose blood was tested, suggesting that, if the urinary tract was infected via the blood-stream, the bacteraemia was of short duration.

Table 4. *Correlation between number of respiratory tract samples examined and isolation of* Salmonella enteritidis

No. of samples investigated from one patient	No. of patients examined	No. of detected carriers	%
1–2	67	12	17·9
3 and more	64	25	39·0

$\chi^2 = 5{\cdot}656$; N = 1; $P = 0{\cdot}02$.

In the upper respiratory tract *S. enteritidis* was isolated from 37 of 131 children examined, 2 from the nose and throat and 35 from the throat alone. It is seen from Table 3 that many of these were repeatedly positive. Throat carriers were found in all the hospital wards involved in the epidemic. They were usually persistent carriers, but a few showed long negative periods followed by a positive result; this may have been due to reinfection. A close correlation was found between the frequency of detection of *S. enteritidis* in the upper respiratory tract and the number of samples examined (Table 4).

In 12 cases isolation of *S. enteritidis* occurred simultaneously with isolation of other bacteria of the *Enterobacteriacea* group: in 10 with *Shigella flexneri* and in 2 with *Salmonella typhi*. These patients had contracted salmonellosis during their treatment in the infectious-diseases ward.

From other materials investigated, 10 strains were isolated: 2 from pus from the ear, 3 from cerebro-spinal fluid and 5 from lung, heart and lymphatic gland tissues taken during autopsies.

S. enteritidis was isolated from 2 out of 25 air samples taken from wards in which respiratory carriers occurred.

Resistance of Salmonella enteritidis *to antibiotics*

All strains isolated from blood, faeces, urine, upper respiratory tract and air were highly resistant to penicillin, chloromycetin, aureomycin, terramycin, tetracyclin and neomycin. They were only weakly sensitive to streptomycin (zone of inhibition = 15–18 mm.) Resistance to antibiotics was found in strains isolated both in the acute stage of disease and in convalescents. Preliminary data also suggest that the clinical effect of these antibiotics was very slight. Antibiotics had no effect upon the carrier-state. Our observations here agree with those of other authors (Seligmann, Barash & Cohlan, 1947; Neter, 1950; Datta & Pridie, 1960).

Table 5. *Examination of blood sera with gm antigen in salmonellosis patients and control group*

Group	No. of examined persons	Agglutination test negative	Agglutination test positive—max. titre 1/50	1/100	1/200	1/400	1/800 or more
Salmonellosis	139	50	16	18	22	21	12
Control	127	122	3	1	0	1	0

The results of serological examinations

The agglutination test was performed with gm antigen on 139 individuals with bacteriologically confirmed salmonellosis. In order to check the specificity of this test it was simultaneously performed on 127 sera from patients with typhoid fever, dysentery and other diagnoses and from healthy blood donors. As is seen in Table 5, only two positive results are found in the control group, while in those infected with *S. enteritidis* a titre of 1/100–1/800 or more was found in 52 % of those examined. This suggests that a titre of 1/100 is specific for these infections and has diagnostic significance. The highest titres were found in the second to the third weeks after onset. In a third of those investigated the agglutinins persisted up to 3 months or more after the onset of infection, suggesting that the test might be useful in retrospective investigations. An increase of titre in the course of infection was not always observed. In patients with bacteraemia or bacteriuria up to 80 % showed positive agglutination reactions; this was 4–5 times higher than in those who were faecal excreters only. Of 22 throat carriers in whom the agglutination test was carried out, 17 had a titre of 1/100–1/1600.

It is noteworthy that there was a considerable number of positive sera from infants up to 3 months of age, in all 48 sera from 36 infants. In nine cases the sera of the mothers of these positive infants were examined, all with negative results.

The period of carrier-state and the significance of age

The frequency of positive faecal cultures and of positive serological results were independent of age (Table 6). Significant differences were, however, found as regards other kinds of examinations. Above 14 years of age, bacteria in urine were found in six samples only (two persons), cultures from blood were obtained

only in children up to the third year of life, and of 115 cultures from the upper respiratory tract, 90 were obtained from infants up to the sixth month of life, 24 from infants aged from 7 months to 3 years, and only 1 from a 6-year-old child. Throat-carriers were also not found among 73 personnel of the Children's Wards, who were examined 2–3 times.

Table 6. *Frequency of* Salmonella enteritidis *isolation from various materials in relation to age of the patients* (*number of samples*)

Age group (at the onset of infection)	Faeces		Urine		Blood		Respiratory tract		Agglutination test	
	Ex.*	Pos.†	Ex.	Pos.	Ex.	Pos.	Ex.	Pos.	Ex.	Pos.
2–14 d.	79	67	29	25	10	6	9	5	3	1
15–30 d.	70	38	35	17	12	1	22	6	8	1
1–3 m.	546	307	294	102	93	9	110	34	82	46
4–6 m.	489	252	282	105	89	3	135	45	78	34
7–11 m.	215	91	116	39	38	3	44	10	28	9
1–3 yr.	286	176	140	51	53	4	53	14	45	24
4–14 yr.	248	128	89	32	26	0	45	1	27	12
15 yr. or more	70	31	39	6	7	0	14	0	7	5

* Examined. † Positive.

Table 7. *Duration of carrier-state in* 309 Salmonella enteritidis *patients*

Period (days)	Localization of bacteria: Faeces		Urine		Blood	Respiratory tract
	No. of patients	%	No. of patients	%	(no. of patients)	(no. of patients)
–10	112*	37·7	38*	27·5	14*	6*
11–30	110	37·1	43	31·2	9	9
31–60	41	13·9	34	24·6	2	8
61–90	15	5·1	13	9·4	0	8
91–120	8	2·7	3	2·2	0	3
121–150	2	0·7	4	2·9	0	1
151 and more	8	2·7	3	2·2	0	2
Total	296	100·0	138	100·0	25	37
Maximal period (days)	291		236		60	236

* The majority of these patients were examined 1–3 times only.

Since in many cases it was difficult to establish the onset of the infection on the basis of the clinical picture, especially in children whose original disease still persisted at the time of their infection with *S. enteritidis*, it was agreed to consider the day on which the first positive culture from any material was obtained as the probable onset of infection. Table 7 shows data concerning the periods of carrier-state in 309 patients, counting from the probable onset of infection.

As might be expected, patients were positive in the blood for the shortest time,

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and only two showed positive blood cultures after the thirtieth day. It is of interest that in four patients positive blood cultures were obtained between 7 and 22 days after the temperature had fallen to normal. In the faeces and urine over 80 % and in the respiratory tract over 60 % were negative after 2 months, but there were a few who continued as carriers for a much longer period. It should be noted that the figures given as maximal periods in Table 7 are not final, as the investigations are not yet complete.

Origin and character of the epidemic

Epidemiological investigations show that, of the total number of salmonella infections diagnosed among patients in the childrens' wards, 12 % may be considered as primary infections, brought from outside ('index cases'), and the remaining 88 % may be considered as hospital infections. The following facts confirm this:

(1) The infections were concentrated in six children's wards, whereas in the remaining thirty-one children's and infectious-diseases wards within the area investigated, although the hospital cases of diarrhoea were examined for salmonellosis, no infections were found.

(2) More than half the cases were admitted to hospital with such diagnoses as pneumonia, influenza, otitis, rheumatic fever, etc., and only 1–3 weeks after admission an unexpectedly high fever or gastro-intestinal disorder occurred. In many of these children the first series of examinations of faeces, urine etc. was negative, and the bacteria were isolated only 1–3 weeks after admission to hospital.

(3) In the area of the epidemic, children with diarrhoea outside hospital were frequently tested bacteriologically for salmonellas; of a total of 151 examined, *S. enteritidis* was found in only three children, of whom two had had previous contact with infected persons.

(4) Of 346 members of the families of the infected children tested 1–3 times, only ten were carriers, and nine of these only after the return of the convalescents to their homes.

(5) In almost all hospital foci, the pattern of infections was intermittent, comprising 3–4 groups of simultaneously occurring infections, with 1-, 2- or 3-week periods of absolute or almost absolute freedom from infections.

It would be difficult to explain all these facts if it is supposed that the infection was endemic in the area examined.

It was possible to exclude the likelihood of the spread of infections by food as prepared in hospital milk kitchens, because (*a*) almost 25 % of those infected had not had their food in such way, (*b*) no carriers were found among the kitchen personnel, despite repeated tests, (*c*) the quality of foods, especially after the introduction of a strict sanitary regime, gave no cause for complaint, (*d*) the central milk kitchen of the Children's Hospital in Lublin supplied three infants' wards with food, yet infections occurred in only one of them.

In the majority of cases it was also possible to exclude direct or indirect contact with infected animals. Towards the end of the epidemic two strains of *S. enteritidis*

were isolated among 160 pigs examined, but these infections are unlikely to have been the cause of this outbreak.

There is thus no doubt that the infections spread in hospital wards by direct contact from man to man. About 60 % of those infected were children up to 1 year of age, and thus without contact with each other, but infection could have been transferred by the hands of the personnel, linen, dishes, teats of nursing-bottles, thermometers and other objects used in nursing. Bacteriological investigations showed that none of these means of transmission can be eliminated: 20–30 % of these objects examined were found to be contaminated with intestinal bacteria (*E. coli*). It should be also emphasized that *S. enteritidis* was twice cultured from the environment—one strain from a swab taken from the metal bed of a sick child and one from a baby's shirt.

The possibility of air-borne infections

The first to draw attention to the spread of salmonellas as an air-borne infection were Varela & Olarte (1942), who isolated salmonellas from the upper respiratory tract. Neter (1950), during a hospital epidemic, isolated *S. oranienburg* from the throat of one child and *S. choleraesuis* from another. In the hospital epidemic described by Datta & Pridie (1960) *S. typhimurium* was found in the nose and throat of five out of fourteen patients tested. Various types of *Salmonella* have been isolated from the air and dust of hospital wards affected by epidemics (Datta & Pridie, 1960; Van Oye, Richard, Moinet & Van Goethem, 1963; Watt *et al.* 1958). The possibility of experimental infections by the respiratory tract in laboratory animals and the development of specific morbid changes have also been demonstrated (Clemmer *et al.* 1960; Darlow, Bale & Carter, 1961; Tully, Gaines & Tigertt, 1963).

In the present investigations, *S. enteritidis* has been found in the upper respiratory tract in thirty-seven cases (Table 3). No less than 39 % of patients examined three or more times were found to be positive (Table 4) and salmonellas were twice recovered from the air. It should be remembered, however, that the isolation of these organisms from the upper respiratory tract is no proof that this was the portal of entry, and our preliminary observations suggest that the localization of these bacteria in the upper respiratory tract, like bacteraemia and bacteriuria, is a secondary phenomenon, a result of their presence in the intestine. The fact that in the great majority of cases observed the bacteria are initially found in the faeces and only later, sometimes after 20–50 days, in the blood, urine, etc., also seems to support the above suggestion.

Despite these reservations it appears fairly probable that some of the cases arose as an air-borne infection. Various epidemiological observations confirm this. A characteristic feature of the observed epidemics was the ease and speed with which the infection spread. The intensity and extent of the epidemic in many children's wards often exceeded the possibilities of diseases transmitted by the faecal–oral route, even if we make allowances for the highly sensitive population in which the infection spread. It was possible to observe sometimes that even a single entry of infection into the wards caused in 1–3 days a wave of a new group of infections,

among children from different rooms who had no contact, directly or indirectly. That some of the observed cases were air-borne is borne out by the fact that routine hygienic measures successfully applied in other foci of alimentary infections, over a long period of time, failed to inhibit the spread of this epidemic. Other authors have also drawn attention to the ineffectiveness of hygienic measures in similar outbreaks (Datta & Pridie, 1960; Neter, 1950; Seeliger & Maya, 1964).

It should be noted that pathological changes, such as inflammation of the throat, lungs, bronchi, etc., were observed in twenty-two throat carriers. In one girl aged 6 months who had not been examined during her illness, salmonellosis was recognized *post mortem* and *S. enteritidis* was isolated from lung tissue taken at autopsy. Other authors (Peluffo, 1964; Saphra & Winter, 1957; Swicowa *et al.* 1962) have also noted symptoms of acute inflammation of the throat in infants with salmonellosis.

To sum up, although the problem of air-borne infection in the spread of salmonellosis needs further investigation, such a method of spread must be considered when methods of control are being planned. Experience gained during the epidemic described confirms the opinion that only such measures as the using of protective masks by the personnel, regular airing of rooms and disinfection of the air (by means of mercury lamps and lactic acid), strict isolation of throat-carriers, etc., together with other hygienic measures, affect the course of a hospital epidemic.

Other epidemiological problems

During the epidemic many cases of infection in newborn infants aged from 2–7 days were observed. When considering the routes of their infection the following possibilities must be taken into consideration: (1) Haematogenous infection from mother-carriers; (2) infection from mother-carriers during or after birth; (3) infection from carriers among the personnel; (4) transmission of bacteria from child to child through hands, napkins or objects used in nursing care; (5) air-borne infection.

In the literature each of these possibilities has its followers and opponents (Abramson, 1947; Neter, 1950; Seeliger & Maya, 1964; Sickenga, 1964; Watt *et al.* 1958). In the epidemic described it was not possible to eliminate any of these modes entirely. Among both mothers and personnel there were several carriers who might be the source of infection for the newborn. On the basis of laboratory investigations and analysis of the entire material it appears, however, that the chief role was played by the transmission of bacteria by the insufficiently disinfected hands of the personnel (38 % of swabs taken from their hands were contaminated with intestinal bacteria), and by air-borne infection.

Transmission of bacteria is in large measure facilitated by the high resistance of *S. enteritidis* in the external environment. Ten positive samples of faeces selected at random were dried and stored at room temperature; from 5, positive cultures were obtained during 3–7 weeks, from 3, during 8–11 weeks, and from 2, up to 13 weeks. These faeces were sampled both in the acute phase of the disease and in the period of convalescence, they came from infants and older children.

Neyman, Stabrowski & Wiza (1954) report an even longer period of the persistence of *S. enteritidis* in dried faeces.

All the investigated strains were highly sensitive to disinfectants (chloramine, sterinol). Inactivation occurred after the action of 0·2 % solutions for 2–5 min.

For obvious reasons the establishment of the incubation period was very difficult. On the basis of various preliminary observations it may be supposed that it is short—several children fell ill 12–24 hr. after exposure to infection. This question, however, requires further investigation.

DISCUSSION

The result of human contact with *S. enteritidis* may be: (1) generalization of bacteria in the organism of the infected person, with accompanying serious clinical syndromes; (2) localization of the bacteria in the intestinal tract with mild enteric disorders; (3) inapparent cases limited to the intestinal phase of the infection; (4) no infection. As has been mentioned, observations made during these investigations suggested that the place of primary localization of *S. enteritidis* in the human organism is probably the intestines, and thence, for various reasons, in some cases the bacteria penetrate to other systems. At present it is difficult to define precisely all the factors which determine the overcoming of the protective barriers of the alimentary tract and the development of one or another form of the disease. In the literature there are data on the effect of such factors as the virulence of particular strains, the natural resistance of the host, the dose of transmitted bacteria, acquired immunity, age and debilitating factors (McCullough & Eisele, 1951, Sickenga, 1964).

Our investigations show that the younger the children, the more frequent were positive findings outside the alimentary tract, and the more severe was the course of the disease. Whereas in children aged up to 1 year salmonellas were detected parenterally in almost 85 % of those examined, in children aged 4–14 years and in adults they were found in the upper respiratory tract in only one patient and were not found in the blood in any. From thirty-nine samples of urine taken from adults salmonellas were found in only six. The effect of debilitating factors was also very clear. Almost 80 % of the infected children were between 10 % and 30 % underweight, 8 % were premature infants and 86 % had intercurrent disease. These last had mostly been treated, before their salmonella infection, with large doses of various antibiotics, which doubtless affected the biocoenosis of the intestines. The period of bacterial excretion was much longer in infants than in older children: a large percentage of infants were positive in faeces, urine or the upper respiratory tract for 5–8 months, but the older children usually became negative in 5–15 days. These data agree with those of Crainz *et al.* (1960), Mihalyfi *et al.* (1961), McCullough & Eisele (1951), Neter (1950), Stahn (1963) and Szanton (1957).

From the epidemiological viewpoint it is clear that the generalized forms, in which the organisms are found in the throat or the urinary tract, are the most dangerous. Since these forms are met mainly in infants, who are in addition most susceptible to infection, this type of salmonellosis is primarily an infection of

infants in hospital, while older persons may be only chance, temporary and sometimes 'blind' links in the epidemic chain. It is characteristic that, of 159 members of the families of forty-nine children discharged from hospital as persistent carriers, only three became infected, one adult and two children aged 4 and 7. It is worth noting here that in the great majority of these families the hygienic conditions were unsatisfactory, and contacts had not been previously vaccinated against typhoid and paratyphoid fevers, which has been shown by Levine, Enright & Ching (1962) to confer some heterologous immunity against salmonellas of groups B and D.

The great difficulties encountered in the control of this outbreak seem to have been due to a combination of many factors, the most important of which were the high susceptibility of children to infection, the tendency to generalization of the infection, the persistent excretion, sometimes for many months, in faeces, urine and upper respiratory tract, the resistance of the organism to drying and to antibiotics and the short incubation period. All these factors contributed to an outbreak in which there were many seriously ill patients, with a high mortality rate amongst the new-born and the infants.

SUMMARY

During 9 months the author observed 309 cases of infection with *Salmonella enteritidis*, of which 88 % were hospital infections in six childrens' wards of three different hospitals. The foci were connected epidemiologically. In 97·7 % of those examined, the bacteria were detected in faeces, in 68 % in urine and in 27·5 % in the upper respiratory tract. Bacteraemia was found in 17·2 %. The bacteria were also detected in two air-samples and in two swabs from linen and furniture. All isolated strains were highly resistant to antibiotics and to drying, but sensitive to the action of chloramine. In infected patients with parenteral localization of bacteria, the agglutination test with specific gm antigen was positive in 80 % of cases. Many patients were persistent carriers for 5–10 months. In adults a short faecal carrier state was usually observed. The epidemic spread by contact, though in some cases it was probably air-borne. Such epidemics are very difficult to bring to an end.

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