J. Hyg., Camb. (1973), **71**, 373
Printed in Great Britain

Dysentery in general practice: a study of cases and their contacts in Enfield and an epidemiological comparison with salmonellosis

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(*Received* 12 *October* 1972)

SUMMARY

During a laboratory study of diarrhoea in a large urban area during the years 1953–68, 5319 Sonne dysentery infections in 2620 households and six cases of Flexner dysentery in five households were confirmed. The annual incidence per 10,000 population fluctuated between 2 and 31 with an average of 12.

Shigella sonnei was found in 10% of new cases of diarrhoea investigated. Plural infections were found in 58% of the households studied and 30% of all contacts examined were shown to be infected. Among these contacts the infection rate was higher for children (42%) than adults (20%), and higher for adult females (24%) than males (16%). The duration of infection was under 2 weeks in nearly half the index cases followed up and longer than 2 months in only 3%. Intermittent excretion was observed in 15%. Repeated Sonne dysentery infection and illness was observed after intervals as short as 5 months. Antibiotic sensitivity was recorded after 1955 and colicine typing after 1960. Changes in antibiotic sensitivity were noted. Children of primary-school age were most susceptible to Sonne dysentery, but symptoms in ill cases were as severe in adults as in children. During years of high incidence cases were concentrated within a small number of primary schools.

Sh. sonnei infections were compared with salmonella infections studied concurrently. Sonne dysentery was a winter disease and most cases were under 11 years old, and case-to-case infection was the usual means of spread. Salmonellosis was prevalent in summer and affected nearly as many adults as children, often persons sharing an article of food. It was more prolonged and severe than Sonne dysentery, but less infectious. In all these respects *S. typhimurium* occupied an intermediate place between Sonne dysentery and 'other salmonellas'.

INTRODUCTION

Bacillary dysentery is a common cause of diarrhoea in England and many outbreaks have been well documented. However, its importance in general practice has been studied less than in outbreaks. Such a study has been made over the years 1953–68 in parallel with a study of salmonellosis already reported (Thomas & Mogford, 1970), among a population of approximately 274,000 in general practices in Enfield. The family doctors in the area, the local health department,

and the Edmonton Public Health Laboratory co-operated in the diagnosis and observation of the cases. The findings are reported below.

METHODS

All bacteriologically confirmed dysentery infections were recorded on cards and filed in the laboratory. The first case of dysentery in any household, referred to the laboratory spontaneously by a general practitioner, was listed as an index case. Such cases were defined as *GP index cases* and the home was visited by a Health Inspector. When there were known cases of dysentery in schools or nurseries, samples from suspected contacts were often sent by a medical officer of health to the laboratory for confirmation. Further, the medical officer of health enlisted the co-operation of the school head-teachers to exclude from school any child who developed diarrhoea or vomiting. These children were referred to their family doctors and not re-admitted until a negative bacteriological report had been received. Infections discovered by such means were listed as *MOH index infections* and they and their households were followed up in the same way as GP index cases. Infected households without a determinable index infection, discovered during the follow-up of contacts, were also visited and listed separately. Wherever possible a record was made on the card of the age, sex, school attended or occupation of each member of the household, and also the date of onset of any symptoms. Each person was asked to send a faecal sample to the laboratory. First specimens were usually received before the start of any treatment. Thereafter the patients were treated by their doctors in various ways.

Patients in whose faeces shigellas were found were asked to send weekly specimens, starting three or more days after concluding any antibacterial treatment, until a negative result had been obtained. The rest of the family were then re-examined. Most families were persuaded to remain under observation until two or three consecutive negative specimens had been collected from each infected person. Negative results from unsatisfactory or dry specimens were disregarded.

Ninety per cent of faeces specimens sent for diagnosis from GP index cases were examined during the first week of illness. Microscopy was followed by culture on MacConkey and on deoxycholate citrate agar plates before and after selenite-F enrichment broth. A second specimen was requested from patients with cellular stools, if no pathogen was isolated from the first. Common pathogens were recognized by conventional methods while rarer species were identified at the Dysentery and Salmonella Reference Laboratories. Colicine typing of *Sh. sonnei* strains was done by the technique of Abbott & Graham (1961) and drug sensitivity by standard disk methods.

RESULTS

The estimated total population concerned in the survey at its mid-point was 273,857. Of these, 53,699 were children aged under 15 years.

Table 1. *Dysentery index infections according to year*

Year	*Sh. sonnei* GP index cases	*Sh. sonnei* MOH index infections	*Sh. flexneri*, GP index cases	Total
1953	127	22	—	149
1954	131	38	—	169
1955	43	16	—	59
1956	184	70	—	254
1957	63	8	—	71
1958	16	—	—	16
1959	125	10	1	136
1960	293	109	—	402
1961	33	10	—	43
1962	192	164	—	356
1963	111	32	2	145
1964	85	86	1	172
1965	111	168	—	279
1966	44	2	1	47
1967	114	51	—	165
1968	43	34	—	77
Total	1715	820	5	2540

Incidence of ascertained infection

The annual rate of *Sh. sonnei* infection varied from 2 to 31 per 10,000 population, with a mean of 12. A total of 5319 individual infections were recorded in 2620 households. There were 1715 GP index cases and 820 were MOH index infections. A further 80 infected households with 166 infected children and 56 infected adults were found during the follow up of contacts. Five infected households with 11 infected persons were found during the screening of new nursery entrants. There were also five index cases and one contact with *Shigella flexneri* infections. Thus, there were episodes of infection in 2625 households during the 16 years and 4·4 % of all households in the area are known to have been affected. Most of these households included primary-school children. Among the MOH index infections 47 % of pre-school and 57 % of school age children admitted to symptoms.

Table 1 shows the annual numbers of dysentery index infections and Fig. 1 shows the incidence in each month for all 16 years combined. The greatest numbers of cases were diagnosed in the months January to May.

Dysentery was notified under the provisions of the 1936 Public Health Act. Fig. 2 shows the annual notification rates per 10,000 population in Enfield, in Greater London and in England and Wales. Average annual notification rates in the three areas were 13·0, 7·0 and 6·5 respectively. The Enfield rates seemed to follow a local pattern and were below the others for years of low incidence, but were much higher during local epidemic years. The notified cases from Enfield were bacteriologically confirmed and included index and contact infections. The England and Wales notifications corresponded closely to total dysentery isolations reported by the Public Health Laboratory Service (CMO, 1953–68).

Except where otherwise specified the following observations refer to *Sh. sonnei*.

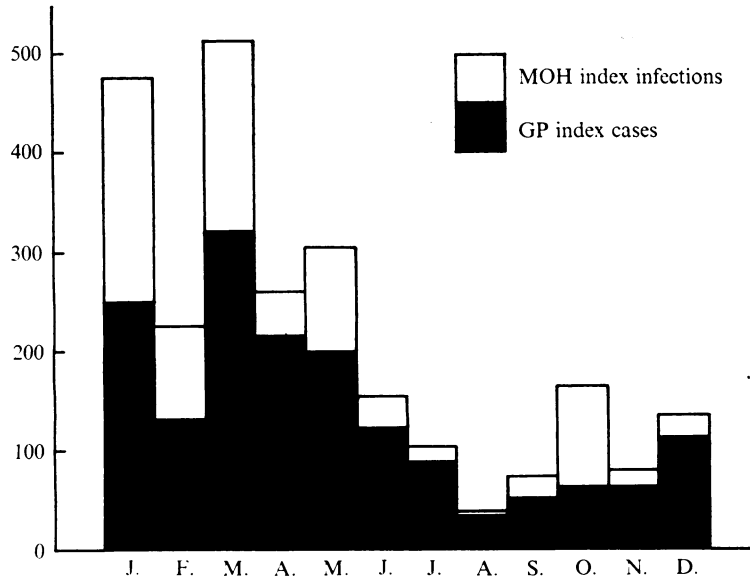

Fig. 1. Incidence of Sonne dysentery according to month.

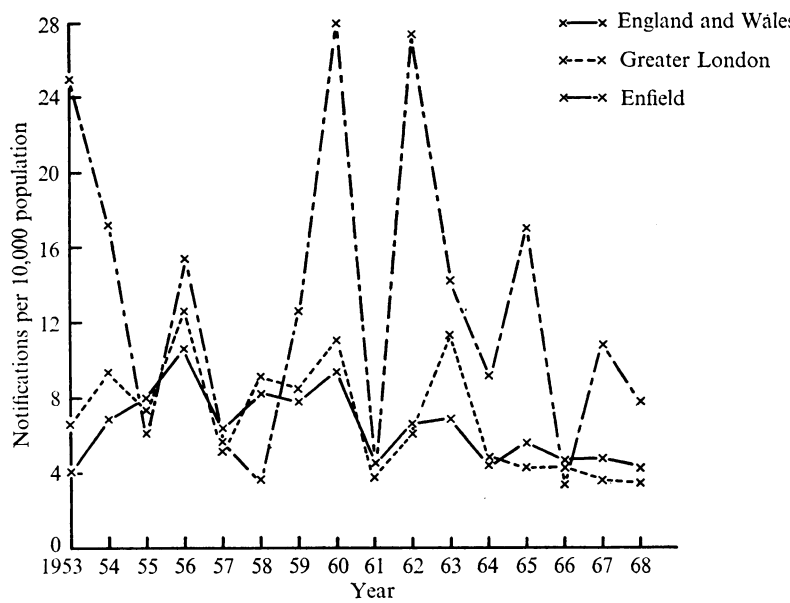

Fig. 2. Annual notification rates to the Registrar General of dysentery in England and Wales, Greater London and Enfield.

Age and sex

Table 2 shows the average annual incidence of index infections per 10,000 of population in different age groups. By far the highest incidence was in the age group 5–9 years, especially of MOH index infections. Within the 10–14 year age group 75 (47%) of the 160 GP index cases and 33 (66%) of the 50 MOH index

Table 2. *Sonne dysentery: incidence according to age group*

Age group	Total no. of GP index cases	Total no. of MOH index infections	Mid-period population	Annual incidence/ 10,000 population of GP index cases	Annual incidence/ 10,000 population of GP index cases and MOH index infections
0–4 years	370	217	17,343	13·3	21·2
5–9 years	783	505	15,676	31·2	51·4
10–14 years	160	50	20,680	4·8	6·3
Child age group unknown	46	5	—	—	—
All children	1359	777	53,699	15·8	24·9
Adult 15+	356	43	220,158	1·0	1·1
Total	1715	820	273,857	3·9	5·8

Table 3. *Sonne dysentery: severity of GP index cases according to age group and sex*

Age and sex group	Admitted early to hospital	Diagnosed at home			Total
		Cells found	No cells found	Not recorded	
Child					
Male	31 (4%)	237 (34%)	427 (61%)	—	695
Female	27 (4%)	285 (43%)	347 (52%)	5 (1%)	664
Adult					
Male	5 (4%)	50 (41%)	65 (53%)	2 (2%)	122
Female	13 (6%)	111 (47%)	106 (45%)	4 (2%)	234
Total	76 (4%)	683 (40%)	945 (55%)	11 (1%)	1715

infections were aged 10 and attended primary schools. Only 102 index infections were found among secondary-school children. Among children there were slightly more male than female index cases – 695 as compared with 664 GP index cases and 399 as compared with 378 MOH index infections. Most of this small male excess was in the 5–9 age group. Among adults there were far fewer male than female index cases – 122 as compared with 234 GP index cases and 6 as compared with 37 MOH index infections.

Severity of illness in GP index cases

These 1715 index cases were sufficiently ill to have called in a doctor. Two criteria were used to assess the severity of index cases – early admission to hospital for medical (not social) reasons, and a record of blood or pus cells in the faeces. Seventy-six (4%) of the 1715 GP index cases were admitted to hospital (Table 3). Among the 1639 (96%) treated at home, cells were found in the first faeces specimen of 683 (40% of 1715), thus 44% were considered to have had a severe illness. Of the 170 faecal samples examined for cells in the second week of illness 29 (17%) were found still to have cells present. A slightly higher proportion of female than of male children had cells in the stools ($P < 0{\cdot}001$). The severity of illness showed no

Table 4. *Antiobiotic resistance of* Sh. sonnei *strains tested*, 1955–1968

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
Sulphonamide, 300 μg.														
No. tested	—	26	5	10	106	223	41	181	115	79	107	33	55	1
No. resistant	—	23	5	9	90	134	15	137	101	71	100	29	55	0
Percentage	—	88%	—	—	85%	60%	37%	76%	88%	90%	93%	88%	100%	—
Tetracycline, 50 μg.														
No. tested	—	2	5	6	74	223	41	193	116	79	107	35	54	24
No. resistant	—	1	5	6	53	114	11	15	3	16	44	7	7	2
Percentage	—	—	—	—	72%	51%	27%	8%	3%	20%	41%	20%	13%	8%
Streptomycin, 25 μg.														
No. tested	—	2	1	5	106	148	1	74	116	78	107	35	55	1
No. resistant	—	1	0	3	0	11	0	20	24	15	65	20	51	1
Percentage	—	—	—	—	0%	7%	—	27%	21%	19%	61%	57%	93%	—
Chloramphenicol, 50 μg.														
No. tested	—	20	5	10	105	161	40	191	116	79	107	33	—	—
No. resistant	—	0	0	0	0	0	0	1	0	0	1	0	—	—
Percentage	—	0%	—	—	0%	0%	0%	1%	0%	0%	1%	0%	—	—
Nitrofurazole, 100 μg.														
No. tested	—	—	—	—	—	175	41	180	116	79	106	44	118	70
No. resistant	—	—	—	—	—	9	0	1	0	1	0	0	0	1
Percentage	—	—	—	—	—	5%	0%	1%	0%	1%	0%	0%	0%	1%
Kanamycin, 30 μg.														
No. tested	—	—	—	—	—	—	—	—	—	56	66	49	119	145*
No. resistant	—	—	—	—	—	—	—	—	—	0	0	4	0	43
Percentage	—	—	—	—	—	—	—	—	—	0%	0%	8%	0%	30%
Nalidixic acid, 30 μg.														
No. tested	—	—	—	—	—	—	—	—	—	—	—	23	126	70
No. resistant	—	—	—	—	—	—	—	—	—	—	—	0	2	0
Percentage	—	—	—	—	—	—	—	—	—	—	—	0%	2%	0%
Ampicillin, 25 μg.														
No. tested	—	—	—	—	—	—	—	—	—	—	—	6	59	65
No. resistant	—	—	—	—	—	—	—	—	—	—	—	3	18	7
Percentage	—	—	—	—	—	—	—	—	—	—	—	—	31%	11%

NB. Percentages are only given when 20 or more strains were tested.
* Including strains tested from a school outbreak beginning in 1967.

Table 5. *Sonne dysentery: duration of infection in GP index cases according to age group and number of terminating negative specimens*

Age group	No. of cases	< 2 weeks	2 to < 4 weeks	4 to < 8 weeks	2 months and longer
		Three or more negatives			
0–4 years	200	93 (47%)	64 (32%)	31 (16%)	12 (6%)
5–14 years	496	194 (39%)	167 (34%)	124 (25%)	11 (2%)
<15 [age unknown]	15	9	3	3	—
15+	159	110 (69%)	32 (20%)	16 (10%)	1 (1%)
Total	870	406 (47%)	266 (31%)	174 (20%)	24 (3%)
		Two negatives only			
0–4 years	104	47 (45%)	32 (31%)	20 (19%)	5 (5%)
5–14 years	342	124 (36%)	127 (37%)	80 (23%)	11 (3%)
<15 [age unknown]	11	7	3	1	—
15+	108	73 (68%)	23 (21%)	11 (10%)	1 (1%)
Total	565	251 (44%)	185 (33%)	112 (20%)	17 (3%)

relationship to the colicine type or drug sensitivity of prevailing strains of *Sh. sonnei*. Although the incidence of dysentery was very much greater in children it was noted that among ill index cases symptoms were of broadly similar severity in children and adults. No deaths were recorded.

Drug sensitivity and treatment

Samples of strains isolated from cases and excreters were tested for drug resistance from 1956 onwards. Table 4 shows results of sensitivity tests to the eight most commonly used antibacterial drugs. The rate of sulphonamide resistance was high, but fell temporarily during 1960 and 1961. Resistance to tetracyline varied, but in some years 80% or more of strains tested were sensitive. Resistance to streptomycin increased, all strains being sensitive in 1959, but less than half from 1965 onwards. All but two of 867 strains tested were sensitive to chloramphenicol and all but 12 of the 929 strains tested with nitrofurazole were sensitive. All strains tested were sensitive to kanamycin until 1966 when four resistant strains of colicine type 0 were isolated in a family outbreak (Thomas & Datta, 1969). Subsequent strains were sensitive until the end of 1967, when a school outbreak began from which 43 kanamycin-resistant type-7 infections were identified (Thomas, Haider & Datta, 1972). Only 2 of 219 strains tested were resistant to nalidixic acid and these were in one family (Thomas & Datta, 1969). About a quarter of 130 strains tested were resistant to ampicillin.

Many cases were prescribed for by their family doctors, but medicine was not always taken as directed. However, 262 children who received supervised treatment with one of the drugs named in Table 4 were studied closely. *Sh. sonnei* persisted or recurred after treatment in 145 (55%) cases, regardless of the *in vitro* sensitivity to the drug used.

Table 6. *Sonne dysentery: annual number of GP index cases and MOH index infections in* 18 *primary schools in Old Edmonton*

School reference	No. of pupils	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	Total
S 2	298	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
S 3	436	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—	2
S 10	175	—	—	—	—	—	—	—	1	—	—	—	—	—	—	2	—	3
S 5	87	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	3
S 18	239	—	—	—	—	—	—	—	—	—	5	—	—	—	—	1	—	6
S 13	301	1	—	—	—	—	—	1	—	—	2	1	—	—	—	—	13	18
S 14	361	2	2	—	2	—	—	2	4	—	2	—	—	—	—	6	—	20
S 12	448	—	—	—	—	—	—	2	2	—	1	17	1	6	—	1	—	30
S 9	471	—	—	—	—	—	—	3	20	—	3	1	—	—	10	1	1	39
S 16	255	2	—	—	—	—	—	6	—	—	15	3	2	—	1	1	14	44
S 19	500	—	2	1	38	—	—	2	2	—	1	—	—	1	—	1	—	48
S 6	560	1	—	13	2	—	—	3	23	3	4	3	—	1	—	10	2	65
S 1	932	—	—	—	—	—	—	—	3	—	—	2	1	64	1	2	1	74
S 11	482	—	—	—	—	—	—	1	—	—	—	—	65	9	—	—	—	75
S 17	357	16	—	—	—	—	—	2	3	—	52	1	—	2	—	4	2	82
S 8	346	—	—	—	—	—	—	1	36	—	51	—	—	7	—	17	3	115
S 4	466	—	24	—	1	—	—	1	64	—	19	—	—	—	—	2	23	134
S 15	773	—	2	—	3	—	—	37	8	—	34	1	2	—	9	56	1	153
Total	7487	22	30	14	46	—	1	61	166	3	192	29	72	90	21	104	60	911

Bacteriological clearance and intermittent excretion

Intermittent excretion was recorded in 15 % of all index cases (264 of 1715). However, 122 of these cases had only a single intervening negative specimen liable to have been collected too soon after antibacterial therapy. Within the survey 745 child index cases were followed up to three or more concluding clearance specimens. Intermittency was recorded in 157 (21 %). In 92 (12 %) there was a single negative and in 60 of these it was the first specimen to follow diagnosis. There were two or more intervening negatives in the remaining 65 (9 %). Only 162 adults were followed to three clearance negative specimens. Intermittency was recorded in 14 (9 %) and in 9 of these there was a single negative from the specimen following diagnosis. There was no sex difference in the occurrence of intermittent excretion. For bacteriological clearance the aim was three consecutive negative specimens, which should have given complete clearance in over 90 % of cases.

Duration of infection in GP index cases

The duration of infection was taken to be from the onset of diarrhoea to the point midway between the last positive and the first negative specimen of a clearance series. Table 5 shows the duration in 1435 (84 %) of the 1715 index cases which were followed to two or more terminating negative specimens. Infection lasted less than 2 weeks in 47 % of 870 cases followed to three or more negatives and in 44 % of 565 cases followed to two negatives. In both groups 23 % of infections lasted more than 4 weeks, including 3 % which persisted longer than 8 weeks. It appears from this table that infection persisted longer in children than in adults. However, some long infections may have been missed in adults since follow-up was incomplete in 89 (25 %) of 365 adult index cases as compared with 191 (14 %) of 1359 child index cases. Adults were not compelled to send in follow-up specimens unless their occupation carried a public-health risk.

Seven infections lasted more than 4 months. These were 18 weeks in a woman aged 81 years, 18 and 21 weeks in girls aged 4 and 2 years respectively, 19 weeks in a girl aged 4 years who also had a Giardia infection, 17 weeks in a boy aged 7, 23 weeks in a boy of 15 sent home from boarding school, and 30 weeks in a boy aged 8 years.

Source of infection

More than half the index cases were pupils at primary schools. A special study was made of schools within the old Edmonton district of Enfield. This area had an average population of 7487 children of primary-school age, which was about 39 % of children of that age group in Enfield. During the 16 years of the survey, 17 of the 18 Edmonton primary schools studied here had bacteriologically confirmed cases of dysentery with a total of 911 children infected. Table 6 shows the annual incidence of GP index cases and MOH index infections in these schools.

An outbreak was defined as five or more proven infections in one term and a large outbreak as ten or more. It is clear that even in years of high incidence (e.g. 1960, 1962) large outbreaks affected only a few schools and most escaped with a few

Table 7. *Colicine typing of samples of* Sh. sonnei *strains tested*, 1961–1968

Colicine type	1961	1962	1963	1964	1965	1966	1967	1968	Total (%)
Type 0	6	8	52	33	69	18	63	42	291 (61%)
Type 7	—	2	26	13	26	—	1	43	111 (23%)
Type 2	2	—	2	7	—	1	6	—	18 (4%)
Type 6	—	1	15	—	2	—	—	—	18 (4%)
Type 4	—	6	5	—	3	—	—	—	14 (3%)
Type 13	—	1	8	2	1	—	—	—	12 (3%)
Type 11	—	—	2	1	1	—	7	—	11 (2%)
Type 1B	—	—	—	—	—	—	—	1	1
Type 3	—	—	—	—	1	—	—	—	1
Type 3A	—	—	1	—	—	—	—	—	1 (1%)
Type 8	—	—	1	—	—	—	—	—	1
Total tested	8	18	112	56	103	19	77	86	479 (100%)

sporadic cases or none at all. The largest proportion of pupils with proven index infection during an outbreak at any of these schools was 15%. The ten secondary schools with 4382 pupils had no dysentery outbreaks and individual cases in this age group were usually in contacts of infected primary-school children.

In one day-nursery which was open in Edmonton throughout the survey, a total of 95 cases were confirmed. The nursery accommodated 55 children. There were four considerable outbreaks during the survey, the largest of which affected 28 (51%) of infants attending.

Nineteen GP index cases of Sonne dysentery were thought to have been contracted abroad. Four of the five index cases of Flexner dysentery had recently been abroad. These were a Flexner 4A from South Africa, a Flexner 6 from Spain, a Flexner 2A from Yugoslavia and an untyped strain from Canada. These strains were studied by the late Dr K. P. Carpenter at Colindale.

Colicine typing

Four hundred and seventy-nine strains of *Sh. sonnei* were colicine-typed from 1961 onwards (Table 7) – 61% (291) were type 0 (non-colicinogenic) and 23% (111) were type 7. Five strains from infections contracted abroad were tested, of which two were type 2 and three were type 0.

Repeated infections

Second infections with *Sh. sonnei* were observed, sometimes after quite short periods of time. For example, during 1954–6 two nurseries suffered two distinct epidemics of dysentery each, separated by clear intervals of 5 and 18 months. Cases and contacts were followed up until three or more consecutive negative specimens had been obtained. Altogether 46 children and one adult were found to have been infected twice within 20 months. At one nursery 11 children were infected twice, 7 were ill in the first outbreak and two of these 7 were ill in the second outbreak 5 months later, while 4 were symptomless on each occasion. At the other nursery 6 children were infected twice, 3 were ill during the first outbreak and 4, including these 3, were ill during the second outbreak 18 months later, while 2 remained well

Table 8. *Infection rates among household contacts of Sonne dysentery*

Age of index case	Age and sex of exposed household contact	No. of household contacts	
		Tested	Found infected
Child	Child		
	Male	1728	765 (44%)
	Female	1692	711 (42%)
	Adult		
	Male	1799	286 (16%)
	Female	2118	525 (25%)
Adult	Child		
	Male	230	67 (29%)
	Female	205	85 (41%)
	Adult		
	Male	290	44 (15%)
	Female	264	48 (18%)
All	All exposed children	3855	1628 (42%)
	All exposed adults	4471	903 (20%)

NOTE. There were a further 20 infections found among 63 household contacts tested whose sex or age was not recorded.

during both infections. Among infected household contacts 18 of 28 children were reported to be ill on the first occasion and 9 on the second. The one adult was symptomless throughout.

The median duration of excretion was shorter in the second infection, being 11 days for the second compared with 24 days for the first infection. However, the interpretation of this comparison is in doubt because the children were older and tetracycline rather than sulphonamide was used to treat the later cases.

Multiple infection

Fifty-two of the 2535 Sonne dysentery index infections were found to harbour other pathogens. These included 29 *Giardia*, 8 *Salmonella* and 7 enteropathogenic *E. coli* infections.

Household infection

Specimens of faeces were collected from other members of the households of 2397 (95%) of GP index cases and MOH index infections. Of these 2397 households 1380 (58%) were found to contain further infected persons, a few with double infections, many without symptoms. The average number of additional persons tested in each household was 3·6 where the index case was a child and 2·8 where the index case was adult. The contact infection rate also tended to be higher when the index case was a child. Infection was higher among contact children (42%) than adults (20%) and among adult females (24%) than males (16%).

Table 9. *Sonne dysentery and salmonellosis compared: features of the two Enfield studies*, 1953–1968

A. TOTAL INFECTIONS

	No. found 1953–68		Annual incidence per 10,000 population	Percentage of new cases of diarrhoea
	Persons	Households		
Sonne dysentery	5319	2620	12·1	10%
Salmonellosis	917	580	2·1	2%

B. INDEX CASES (GP)

	Average no. per year	Range	Annual incidence per 10,000 popn.	Age and sex	Seasonal variation	Severity of illness	Duration of infection	Inter-mittent excretion
Sonne dysentery	107	16–293	3·9 (children 15·8 adults 1·0)	Many more children than adults (3·8:1) more female than male adults. Primary-school children affected twice as often as pre-school children	A winter excess	4% were admitted to hospital and just under a half of the remainder had blood or pus in their stools	23% of infections lasted more than 4 weeks and 3% more than 2 months. Children may have had slightly longer duration than adults	15% of cases
S. typhimurium	23	5–39	0·8 (children 2·5, adults 0·4)	More child than adult cases (1·4:1) and more males than females. Twice as many cases of pre-school as primary-school age	A summer excess until 1964	13% were admitted to hospital and half the remainder had blood or pus in their stools	50% of infections lasted more than 4 weeks and 21% more than 2 months. Children had slightly longer duration than adults	20% of cases

Table 9 (*cont.*)

B. INDEX CASES (GP) (*cont.*)

	Average no. per year	Range	Annual incidence per 10,000 popn.	Age and sex	Seasonal variation	Severity of illness	Duration of infection	Inter-mittent excretion
Other salmonellas	11	3–27	0·4 (children 0·8, adults 0·3)	Fewer child than adult cases (0·7:1) and slightly more females than males. Twice as many cases of pre-school as primary-school age	A summer excess	17% were admitted to hospital and just under a third of the remainder had blood or pus in their stools	57% of infections lasted more than 4 weeks and 26% more than 2 months. Children had slightly longer duration than adults	20% of cases

C. SPREAD OF INFECTION

	Source of infection	Infection of household contacts
Sonne dysentery	Over half the index cases were children attending primary schools, many arising during outbreaks. Outbreaks were reported in nurseries, but not secondary schools. 1% of index cases probably became infected during foreign travel. Case-to-case spread was common.	58% of households had infected contacts and 30% of household contacts became infected (42% of child and 20% of adult contacts).
Salmonellosis	Less than a fifth of index cases were of primary-school age. 8% of cases arose in known food-borne outbreaks and 3% were probably contracted abroad. The remainder were sporadic household episodes among those sharing foodstuff. Evidence of case-to-case spread was rare.	36% of households had infected contacts and 18% of household contacts became infected (24% of child and 16% of adult contacts).

Dysentery and salmonellosis compared

Table 9 summarizes findings in the concurrent surveys in Enfield during the years 1953–68. The salmonella study has been reported (Thomas & Mogford, 1970).

The incidence of *Sh. sonnei* was 6 times that of salmonella infection, with a much higher proportion of child cases and infections. More than 4 times as many households were infected by *Sh. sonnei*, and case-to-case spread was evident. Most Sonne infections arose from outbreaks in primary schools. Salmonellosis did not spread in schools, but was more often associated with infected foodstuffs, especially in the summer season. Little evidence of case-to-case spread was found. More of the salmonella than of the Sonne dysentery infections were associated with severe illness and prolonged excretion. Intermittent excretion was seen in 20% of salmonella and 15% of *Sh. sonnei* infections. Cellular stools were more common in *Salmonella typhimurium* infections than in other salmonella or Sonne infections. In several respects *S. typhimurium* occupied a position intermediate between 'other salmonellas' and *Sh. sonnei*.

DISCUSSION

This 16-year study of shigellosis in family practice in North London was made concurrently with our investigation of salmonellosis. It had the same advantages of a reasonably stable community, the co-operation of family practices in the same district over many years, the active participation of the public-health department throughout, and co-ordination by a single laboratory of the Public Health Laboratory Service.

During the period concerned, 1953–68, an average of about 30,000 cases of bacillary dysentery and 30 deaths were notified each year in England and Wales. There has been an unexplained sharp fall in notifications since 1969, although there has not been as great a fall in deaths. Meanwhile, however, the diagnoses of dysentery and gastroenteritis, taken together, recorded by the Royal College of General Practitioners since 1967 have shown an increase.

There was a remarkable general fall in dysentery notifications in England and Wales after the war, but this trend was reversed by 1950. In the 5 years preceding this study Sonne dysentery had at first been a rare disease in Enfield – only four cases being diagnosed from 1948 to November 1950. Then an increasing number of school and nursery outbreaks arose. During the years of survey, 1953–68, *Sh. sonnei* accounted for 10% of all new diarrhoea cases investigated, whereas salmonellosis accounted for 2% and only six *Sh. flexneri* infections were seen. No other shigella species was encountered. In England and Wales at this time *Sh. flexneri* represented 2·1% of the total dysentery isolations reported by the PHLS, but in some British cities studied from 1962 to 1966 by Hunponu-Wusu (1970) Flexner dysenteries were common – in Birmingham 13% and in Glasgow 28% of dysentery isolations.

The liability to *Sh. sonnei* infection and to gastroenteritis was greater in childhood than in adult life. The incidence, already high in the pre-school age group, rose greatly in primary-school children and then fell sharply in secondary-school

children and was lower still in adults, where it was only a little higher than that of salmonellosis. Repeated infection was noted in several families and in index cases at two day-nurseries. It appears that immunity to infection and to disease can be very short-lived. The duration of immunity after oral vaccination has not yet been fully assessed (Mel *et al.* 1971; Linde, Koch & Urbach, 1972; W.H.O., 1972).

We found little evidence of case-to-case spread of salmonellosis. In contrast there was evidence of a considerable amount of case-to-case spread of Sonne dysentery within primary schools and nurseries, but *not* in secondary schools, where sporadic cases were the rule. Multiple infections were found in 58% of households and in many of these a clear history of successive cases of clinical dysentery was available. Nearly twice as many adult females as males were found to be infected in households where the index case was a child. This we assume to indicate the greater exposure to infection of the mother of young children. These proportions were not unlike those reported by Hollins (1970), particularly with regard to the high incidence in primary-school children.

In contrast with our observation that salmonella infection showed a summer predominance until 1965, *Sh. sonnei* infection tended to follow the school year, with its large September intake of susceptible 5-year-olds. A few cases in October were often followed by outbreaks later in the winter. Since epidemics were not found to be associated with a uniform rise in incidence, but were the sum of localized outbreaks, it would appear that the early detection and limitation of such outbreaks could prevent large epidemics.

Sharp (1972) has observed that undernotification is common. Notifications for Enfield included a proportion of cases which ordinarily remain undiagnosed, especially during epidemics. Reid (1969) indicated the importance of engaging the support of the local population to identify cases and carriers. The Enfield policy involved the co-operation of the Medical Officers of Health with school teachers in the identification of cases and the supervision of strict hand and toilet hygiene (Thomas, 1966). It has been reported that about two-thirds of children become infected in uncontrolled primary-school outbreaks (Annotation, 1966). The highest incidence of index infections in any school in this study was 15% of the school population – a figure which does not include infected siblings.

It became clear that outbreaks in primary schools and nurseries were the foci of dysentery dissemination and that the control of these outbreaks contributed to the health of the community. In this survey only a small proportion of pre-school children attended nurseries, but even among this small number many cases of dysentery were observed. No outbreaks were related to a particular foodstuff. The school meals staff in the area were screened regularly for intestinal infections, but *Sh. sonnei* was very seldom found except during outbreaks in the school concerned. Perhaps infected catering staff, initially victims of an outbreak, may have helped to extend some of the outbreaks.

Some family doctors prescribed antibacterial drugs for cases of gastroenteritis. Knox (1972) concluded that antibiotic treatment made no difference to bacterial clearance of shigella infections. We commonly recovered *Sh. sonnei* from patients after treatment. Like Farrant & Tomlinson (1966) we observed changes in anti-

biotic sensitivity. By the end of the survey most strains of *Sh. sonnei* were resistant to sulphonamides and streptomycin, many to tetracycline and ampicillin; but very few to chloramphenicol, nitrofurazole and nalidixic acid. The first strains in England resistant to nalidixic acid and to kanamycin were reported (Thomas & Datta, 1969) and an outbreak of kanamycin-resistant infection was observed (Thomas *et al.* 1972).

Sh. sonnei infection was less prolonged than salmonella infection – a quarter of the cases as compared with a half lasted longer than 1 month and 1 % as compared with 10 % longer than 3 months. Excretion may have persisted longer in children than in adults. There was no card index of cases before 1953 available for analysis, but it may be interesting to record that during 1951 and 1952 a median duration of 26 days for *Sh. sonnei* infection in a group of 292 untreated children was compared with that of 23 days among 148 given sulphonamides. These median spans were longer than those of about 17 days observed in children throughout the period 1953–68, but the distribution of duration in the earlier cases is not recorded. If this difference is real it may possibly be explained by changes in immunological experience, infecting strains, or treatment. In 1944 Fairbrother found that half of all cases were still positive 2 weeks after onset and 30 % were still positive at 1 month.

The traditional view that a single negative is not sufficient for clearance was again substantiated. Hollins (1970) reported intermittent negatives in 17 % of cases, which compares with the 21 % we found among child index cases. Three consecutive negatives appear to have provided a practical margin of safety. Among children 9 % were observed to relapse after two negatives, and so it appeared that three negatives should have given complete clearance for over 90 % of infections. The amount and virulence of infection offered by intermittent excreters may well be less than from regular excreters (Andreeva *et al.* 1972), but there are circumstances in which they pose a danger. In residential institutions three negatives might not be sufficient and four or five would be safer.

A smaller proportion of *Sh. sonnei* than of salmonella index cases were admitted to hospital. Paradoxically, cellular dysenteric stools were seen rather *less* frequently in Sonne dysentery than in salmonella infections.

Sh. sonnei and salmonella infections were compared in the same population over the same period of time. The Sonne dysentery infections were somewhat briefer and milder, but their much higher incidence and infectivity and their liability to cause repeated infection pose a public-health problem which is at least as great as that of salmonellosis.

This study was made possible by the co-operation of General Practitioners, Medical Officers and many individual members of the Health and Education Departments, also the Head Teacher and staff of many schools in Enfield and in the old boroughs of Southgate and Edmonton. Our thanks are due to them and to the technical staff of the one-time Edmonton Public Health Laboratory, especially the late J. H. Cowlard, and to Dr T. M. Pollock for much help with the report.

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