between 20% and 30%. While the present report was in progress another was published (Frazer, 1948) which is salutary to all who had been achieving rates of about 10%, for in Belfast the commendably low figure of under 3% was reached. So far as can be ascertained the criteria of infection used by each observer were similar to those employed at Cambridge.

It will be appreciated from Table III that eye infections are usually the most prevalent and skin infections next so. However, Frazer's figures and those of Unit B show skin

TABLE III.—Records of Neonatal Infection Rates

	Cambridge 1947-8		Edinburgh (Henderson, 1943) 1940-2	Bristol (Corner, 1946) 1944-5		London St. Heller* 1945	Belfast (Frazer, 1948) 1946-7
	Unit A	Unit B		A	B		
Total live births	1,257	185	8,075	3,344	3,190	1,293	2,274
Total infections	8.28%	10.28%	29.8%	25.9%	29.7%	21%	2.77%
Eye infections ..	5.4%	1.62%	15.9%	13.49%	17.6%		0.61%
Skin infections ..	2.06%	4.32%	6.8%	6.58%	10%		1.58%
Thrush ..	0.32%	0	4.9%				0.35%

* Department of Health for Scotland Report, 1947, p. 24.

infections to be nearly three times more common than eye infections. It is therefore interesting to conjecture whether the covering of the cot with gauze as practised by Frazer, which minimizes dust-borne infection, and the removal of the babies during the cleaning of the ward in Unit B in Cambridge had any part in the reversal of the usual finding.

The incidence of infections in hospital nurseries must be related to the quality and number of staff available. However, it would also seem likely that the architectural arrangements of the unit are of great importance. In the Belfast Maternity Home (Frazer, 1948) the basic units accommodated five or six mothers and babies, and the number of deliveries was such that a unit could be filled within 24 hours, allowing a thorough cleaning and airing of each unit for 24 hours between each intake. These arrangements would seem to be a factor in reducing cross-infections. These small units are very different from the large nursery for 50 babies described by Corner, even though the Bristol nursery was partially divided into three sections. In the Edinburgh nurseries, on which Henderson reported, a large number of babies are also collected in one room (personal communication).

These observations suggest that one way of reducing the hospital neonatal infection rate would be to reduce the number of babies in each nursery unit. By reducing the infection rate among newly born infants the death rate from infection in this age group should also be reduced. Infections are responsible for over 25% (Department of Health for Scotland, 1947) of neonatal deaths, and they are the most readily preventable cause.

I would like to thank Dr. Allan McFarlan, Dr. French, and the staff of the County Maternity Unit for their help and co-operation.

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THE RELATION OF STAPHYLOCOCCUS PYOGENES TO INFANTILE DIARRHOEA AND VOMITING*

BY

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The aetiology of infantile diarrhoea and vomiting remains obscure despite the efforts of many investigators. Amongst the many suggested causative bacterial agents mentioned is the staphylococcus. The purpose of this paper is to present the findings in an investigation to determine whether *Staphylococcus pyogenes* was a possible direct cause of the gastro-intestinal condition. The staphylococcus in relation to parenteral infection as a cause of diarrhoea and vomiting is not considered.

Draper and Brown (1946) recorded the presence of *Staph. aureus* in the stools in 26.5% of infants aged 0-1 year suffering from enteritis. One death occurred, in a child 8 months of age who had had a history of diarrhoea for six weeks before admission to hospital and died nine days later; the faeces contained pus and mucus. Felsen and Wolarsky (1942) reported an outbreak of epidemic diarrhoea of the newborn in 19 babies; they found *Staph. aureus* in pure culture in two cases, and it was the predominating organism in a third case. These authors suggested that the presence of *Staph. aureus* was significant, but they were uncertain whether their evidence was sufficient to incriminate any single bacterial agent. Kramer (1948) reported a fatal case of enteritis in a child aged 6 weeks, and described the condition as one of staphylococcal enteritis on the finding of a coagulase-positive streptomycin-resistant *Staph. aureus* from the terminal ileum at necropsy. *Staph. aureus* was not cultured before the child's death.

Crowley *et al.* (1941), in their investigation of epidemic neonatal diarrhoea in maternity hospitals, found a coagulase-positive *Staph. aureus* in two cases in a series of 10 infants. They concluded from the evidence that there was nothing to justify the claim that the staphylococcus was anything more than a possible cause in some outbreaks. Taylor *et al.* (1949), in a series of 19 babies in two outbreaks of infantile diarrhoea and vomiting, found *Staph. pyogenes* in the stools on six occasions, and showed by phage-typing that the staphylococci did not belong to the types commonly present in staphylococcal food-poisoning. Because they found a low incidence and a sparsity of staphylococci in rectal swabs they discontinued further phage-typing.

The incidence of staphylococci in the stools of normal infants has been recorded by Duncan and Walker (1942), who found *Staph. aureus* in 74.4% of 61 newly born infants (method of isolation not stated), and by Martyn (1949), who, using a selective medium for the isolation of staphylococci, reported the presence of *Staph. pyogenes* in 50% of 130 healthy infants aged 0-7 days. Crowley *et al.* (1941) isolated *Staph. aureus* once in 57 normal breast-fed infants aged 3-23 days.

*This work was undertaken whilst holding the Cow and Gate Research Fellowship in Child Health, University of Manchester.

The Present Investigation

This paper records the results of an investigation into the incidence of *Staph. pyogenes* in the stools (a) of infants in hospital suffering from diarrhoea and vomiting, (b) in infants in hospital not suffering from gastro-intestinal symptoms, and (c) in a number of healthy babies attending a child-welfare clinic. The last two groups were examined to serve as controls.

All the infants in this series were aged between 2 weeks and 1 year. The majority of them were in the age group 1-3 months. The investigation was carried out between October, 1948, and July, 1949, and includes cases from four hospitals.

Bacteriological Methods.—Rectal swabs from the infants were plated as soon as possible after collection on horse-blood-agar plates and inoculated into a 10% NaCl meat medium recommended by Maitland and Martyn (1948) as being selective for staphylococci. All staphylococci isolated were tested for coagulase production; all positive strains are referred to as *Staph. pyogenes*, and these strains were tested for sensitivity to penicillin (40 units per ml.) and streptomycin (1,000 units per ml.), using soaked strips of filter-paper laid over 18-hour broth-culture streaks of the organism on agar plates. In addition all *Staph. pyogenes* strains were bacteriophage-typed, using the series of phages in routine use at the Central Public Health Laboratory, London. The strains classified as non-typable were tested against all the staphylococcal phages. In every case strains were tested against Kreuger phage.

Results of Culture.—Cultures were made from 119 infants with diarrhoea and vomiting, from 78 infants in hospital with no gastro-intestinal symptoms, and from 44 healthy infants attending a child-welfare clinic. The results are summarized in Table I. The incidence of *Staph.*

TABLE I.—Incidence of *Staph. pyogenes* in Cases of Infantile Diarrhoea and Vomiting and in Controls, with Results of Sensitivity to Penicillin and Streptomycin

Source	Cases of Infantile Diarrhoea and Vomiting	Controls		
		In-patient	Out-patient	Total
Total Nos. of cases	119	78	44	122
<i>Staph. pyogenes</i> isolated	53 (44.5%)	41 (52.5%)	15 (34%)	56 (46%)
Penicillin-resistant	15 (28.3%)	13 (31.9%)	9 (60%)	22 (43.9%)
Streptomycin-resistant	2	2	0	2

pyogenes in cases (44.5%) and in controls (46%) showed a close similarity. There was a low incidence of streptomycin-resistant strains, only four being isolated. The frequency of penicillin-resistant strains was little different in cases and controls in hospital, but was higher in the out-patient controls; the difference is not, however, statistically significant. In Table II the incidence of

TABLE II.—Incidence of Phage Types in Strains of *Staph. pyogenes* Isolated from Cases of Infantile Diarrhoea and Controls

Source of <i>Staph. pyogenes</i>	Numbers of Phage Types											
	Not Typable	6	6/47	31	47/53	47/54	47	47B	52	52A	53	54
Cases of diarrhoea and vomiting (53 strains)	11	1	5	1	2	4	19	2	2	3	2	1
Controls (56 strains)	9	2	5	3	1	2	19	1	6	0	4	1

bacteriophage types of the *Staph. pyogenes* strains isolated is recorded; the nomenclature, as already stated, is that used by the Central Public Health Laboratory. The

distribution of types and the proportion of non-typable strains was similar for cases and controls. It is noteworthy that one type (47) accounted for almost half the typable strains. This type was also found to be prevalent in the staphylococci isolated from healthy newborn infants (Martyn, 1949), the strains having been typed after publication, and nearly all these type 47 strains were penicillin-resistant. Of the 38 strains of phage type 47, 26 were penicillin-resistant. Type 6/47 is recorded five times in the two groups: this type has been shown by Allison (1949) to be often associated with staphylococcal food-poisoning. There were 20 non-typable strains.

Discussion

The presence of *Staph. pyogenes* in the stools of 44.5% of infants suffering from diarrhoea and vomiting and in 46% of controls who either were not suffering from diarrhoea and vomiting or were normal, the close similarity of phage-type distribution in the two groups, and the close correlation of sensitivity to streptomycin and penicillin do not seem to indicate that the organism bears any causal relationship to infantile diarrhoea and vomiting.

The use of a highly selective medium for the isolation of *Staph. pyogenes* from the stools explains the high incidence of the organism, as on only four occasions was *Staph. pyogenes* isolated direct on blood agar—twice in cases and twice in controls.

There were 13 deaths recorded in children examined bacteriologically; in four of these *Staph. pyogenes* was isolated, but then only as a result of using the selective salt-meat medium. It should be mentioned that the number of staphylococci in the original inoculum was not known. In cases and controls in which *Staph. pyogenes* was present there may have been fewer than 10 organisms, because, as Maitland and Martyn have shown, the salt-meat medium will detect small numbers of staphylococci when mixed with large numbers of other bacteria. The failure to isolate staphylococci direct on blood agar, except in four instances, suggests that the number of staphylococci present in the stools is very low. The failure of cases to respond to streptomycin therapy (Holzel, Martyn, and Apter, 1949) does not suggest that an organism nearly always found to be sensitive to the antibiotic *in vitro* bears any causal relationship to the disease. None of the cases in this investigation were found to have either blood or pus in the stools as did many of the cases recorded by Draper and Brown (1946): whether they were dealing with the same clinical condition is a matter of conjecture.

If consideration is given to all the data available there seems to be no evidence that *Staph. pyogenes* bears any direct causal relationship to infantile diarrhoea and vomiting.

Summary

A bacteriological investigation of the incidence of *Staph. pyogenes* was carried out in cases of infantile diarrhoea and vomiting and in infants not suffering from any gastro-intestinal abnormality.

Staph. pyogenes was isolated from 44.5% of the stools of 119 cases of diarrhoea and vomiting and from 46% of controls. Only four streptomycin-resistant strains were encountered in 109 strains of *Staph. pyogenes* tested.

Bacteriophage types were distributed evenly in the two groups. Type 47 predominated, being found in 35% of the total number of strains tested. A food-poisoning type (6/47) was found five times in each of the two groups. The relationship of *Staph. pyogenes* to infantile diarrhoea and vomiting is discussed, and the general conclusion is drawn that this organism bears no relationship to the disease.

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MORTALITY AND SURVIVAL RATES IN MALES WITH SILICOSIS OR SILICO-TUBERCULOSIS

BY

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Whilst the literature on silicosis and silico-tuberculosis is voluminous, there are few published data on the expectation of life in these two conditions. So far as silico-tuberculosis is concerned, as the prognosis is obviously dominated by the tuberculous element its assessment is not unduly difficult to the experienced chest physician. The necessity for data is much greater in silicosis without tuberculosis, as the question of expectation of life may be raised in connexion either with life insurance or with compensation, but most physicians see too few cases to establish criteria. The data upon which this paper is based have been accumulated by one of us (H.M.T.) in Sheffield during the last 19 years; the statistical analysis is the work of the co-author (W.J.M.).

Sheffield is traditionally the home of the grinder, but it is perhaps not so well known that a number of other trades in Sheffield also carry an occupational hazard of silicosis. These trades are sand- and shot-blasting, fettling steel, steel-dressing, ganister mining and quarrying, ganister-crushing, silica-brick making, building, repairing, and scaling furnaces lined with silica bricks, stone-masonry and stone-dressing, and finally coal-mining. Records have been accumulated of 857 men in whom some degree of silicosis or of silico-tuberculosis has been diagnosed. Of these 43 had no opportunity of reaching the age of 40 years, and have been excluded. The series therefore consists of 814 men with silicosis or silico-tuberculosis each of whom reached the age of 40 years and had the opportunity of reaching the age of 41 or more.

The reasons for the selection of 40 as the commencing age in the series are as follows. Silicosis is a condition which develops gradually as a result of an occupational hazard over a period of years. The proportion of cases in which it is possible to diagnose silicosis with certainty below the age of 40 varies in different processes, but is

comparatively small. After the age of 40 this proportion increases fairly rapidly. Nevertheless, even before the lung changes have progressed to diagnostic level on a radiograph, they have from a pathological point of view been initiated and such risks to health as may be associated with silicosis have started to operate. With the same line of argument, it appears logical to credit a case in which silicosis was first diagnosed at the age, say, of 52 with survival from age 40 to age 52, because there can be no doubt that the silicotic hazard has existed continuously since the age of 40. It is necessary to have some standard with which comparison of the survival rates in silicosis and silico-tuberculosis can be made. For this purpose the data in the English Life Table No. 10 (Registrar-General, 1931) have been used. From the "lx" column a percentage survival rate for ages over 40 has been calculated. This represents the survival rates for males in England and Wales starting at age 40.

Survival rates at ages over 40 for silicosis and silico-tuberculosis together with the control survival rates are given in Table I and expressed graphically in the Chart.

TABLE I.—The Number of Survivors at Each Age Expressed as a Percentage of the Number at Age 40

Age	Silico-tuberculosis (466 Men)	Silicosis (348 Men)	English Life Table No. 10 (1930-2)
40	100	100	100
41	98.7	99.4	99.4
42	97.2	99.1	98.8
43	95.3	98.6	98.2
44	94.0	98.3	97.5
45	91.8	97.7	96.8
46	89.2	97.4	96.0
47	87.0	96.5	95.2
48	84.3	95.8	94.3
49	81.9	94.2	93.4
50	78.1	92.6	92.4
51	75.3	90.9	91.4
52	72.6	87.6	90.3
53	69.2	86.6	89.1
54	66.9	84.5	87.9
55	63.6	80.0	86.5
56	59.9	76.8	85.1
57	55.6	72.5	83.7
58	50.1	70.6	82.1
59	44.7	66.0	80.4
60	39.7	61.4	78.6
61	35.3	57.7	76.7
62	31.4	53.5	74.7
63	25.7	49.2	72.5
64	22.2	44.9	70.3
65	20.0	40.3	67.8
66	16.3	36.5	65.3
67	14.6	30.6	62.5
68	11.1	26.6	59.7
69	9.0	21.4	56.7
70	5.7	18.0	53.6
71	4.5	16.3	50.3

Chart showing percentage of survivors from age 40.