

STAPHYLOCOCCAL INFECTIONS IN GENERAL PRACTICE

BY

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Staphylococcus aureus is responsible for a wide group of superficial lesions such as boils, impetigo, sycosis barbae, wound infections, conjunctivitis, and styes. In this study, from an averaged-sized practice in North London, only cases of boils and styes have been selected for a clinical and bacteriological investigation during the years 1950-3. Although these infections cause a vast amount of minor ill-health in the home and factory, their main features have been almost exclusively studied in hospitals.

The family doctor is well placed to consider certain simple problems of staphylococcal infection. For example, what are the common sites on the body for boils? What age groups are affected? Do these infections tend to occur in families? What is the nature of recurrent infection? What is the incidence of penicillin-resistant infections in general practice?

In the study of these questions the phage method of typing proved of the greatest value. As Williams and Rippon (1952) have pointed out, it distinguishes patterns of phage susceptibility rather than fixed types of staphylococci, but "if the use of this method is confined to answering the sort of questions that it is competent to answer—namely, the identity of sets of cultures—there can be little doubt of its value."

Method of Investigation

When a patient came to the surgery with a boil or stye a brief history was taken in which was recorded the site, previous attacks, and whether other members of the family were affected. Dry swabs were then taken from the lesion and also from one nostril, and these were sent by post to the Central Public Health Laboratory. There they were examined for staphylococci, and sensitivity tests were performed by the routine dried disk method. The staphylococcal cultures were then phage-typed at the Staphylococcal Reference Laboratory. In order to obtain a growth of staphylococci from boils or styes which had not burst, it was necessary to make a small incision to obtain frank pus. Swabs taken from the intact overlying skin of a boil did not regularly yield *Staph. aureus*, and, even when a growth was obtained, one could not be certain that the organisms were not those normally found on the skin in some 20% of healthy individuals (Miles *et al.*, 1944).

Clinical Features

Social Conditions.—The 81 patients in this series all lived on the London County Council Woodberry Down Estate. The families live in large blocks of flats within a "neighbourhood unit" with its modern day-nursery, primary school, and small welfare home for the aged. It was noteworthy that under these ideal housing conditions the severe forms of staphylococcal infection—large carbuncles, osteomyelitis, and staphylococcal pyaemia—were not encountered.

Age Incidence.—Table I shows the age distribution of the 81 patients with boils and styes compared with 500 patients selected alphabetically from the practice. During infancy and early childhood these infections were relatively less common. The incidence rose during 5-19 years to 44%

TABLE I.—Age Distribution of 81 Patients with Staphylococcal Infections

	Under 5	5-19	20-44	45-64	Over 65
Random sample from practice	15%	28.6%	37.8%	10.8%	7.8%
Patients with staphylococcal infection	1 (1.3%)	33 (40.7%)	41 (50.6%)	3 (3.7%)	3 (3.7%)

of cases and remained high in the 20-44 age group, but in later life the incidence again declined.

Site of Lesions.—The common sites of infection were: eyelids (22%), forearms (19%), face (14%), axilla (8%), nose (8%), back of neck (4%), other sites (25%).

Phage-typing of Staphylococci

A total of 181 different strains of staphylococci were tested and 147 (81%) of the cultures were typable. Of the 113 strains isolated from the frank pus of boils or styes, 96 (85%) were typable. The 68 nasal strains yielded a slightly but not significantly lower proportion—51 (75%)—of typable strains ($\chi^2=2.6$, D.F.=1; $0.05 < P < 0.1$).

Williams and Rippon (1952) have described three broad groups (I, II, and III) of phage patterns found in staphylococci. According to Rountree (1953), in Sydney there is a preponderance of Group II strains in cases of boils. In 45 strains from her patients with boils, 5 were penicillin-resistant and belonged to Group III, and 50% of the remaining strains belonged to Group II.

In this investigation 93 of the strains isolated from the pus of boils and styes were tested for penicillin sensitivity and 23 (25%) were found to be resistant (Table II). Of

TABLE II.—Frequency Distribution of Phage Patterns in 93 Strains of Staphylococci from Boils and Styes

	Present Series (London)		Rountree (Sydney)	
	Penicillin-sensitive (70)	Penicillin-resistant (23)	Penicillin-sensitive (40)	Penicillin-resistant (5)
Group I	25 (36%)	12 (52%)	12 (30%)	
" II	32 (46%)	1 (4%)	20 (50%)	
" III	3 (4%)	2 (9%)	4 (10%)	5
Not lysed	10 (14%)	8 (35%)	2 (10%)	
" classified ..	—	—	2	

the 70 penicillin-sensitive strains, 32 (46%) belonged to Group II and possessed phage patterns 3A, 3B, 3B/3C, 3C/51, etc. These results show a close correspondence with those obtained by Rountree. Williams and Dowsett (1953), in a less homogeneous series of patients with minor septic lesions, did not observe this preponderance of Group II strains, but they admit the possibility that such a preponderance may have been masked by a number of patients cross-infected in hospital.

Nasal Staphylococci in Boils and Styes

Coagulase-positive staphylococci were cultivated from a nasal swab from 48 (68%) of the 71 patients with boils and from 17 (77%) of the 22 patients with styes (Table III).

TABLE III.—Nasal Staphylococci in Patients with Boils and Styes

	Identical Strains in Lesion and Nose	Strains in Lesion and Nose Not Typable	Different Strains in Lesion and Nose	No Nasal Staphylococci
Boils (71)	26 (37%)	10 (14%)	12 (17%)	23 (32%)
Styes (22)	17 (77%)	—	—	5 (23%)

Valentine and Hall-Smith (1952), who reported a nasal carriage rate of 68-80% in cases of furunculosis attending the out-patient department of the London Hospital, also compared the nasal strain and the strain from the lesion in 25 of their cases, and concluded that the two were identical in every case. Similarly, Tulloch (1954) found that 18 (81.8%) out of 22 typable pairs of cultures obtained from cases of furunculosis were identical.

In this series, however, the pairs of cultures were tested in 71 cases of boils, and in 12 (17%) the nasal strain was either a different type from the lesion (7) or was incapable of phage-typing (5) (Table IV).

TABLE IV.—12 Cases of Boils with Different Strains of *Staphylococci* in Lesion and Nostril

Case	Date	Age	Sex	Site of Boil	Phage	Penicillin Sensitivity
T. B.	22/3/52	14	M	Abdomen N/S	3C 42C	S R
J. H.	6/1/53	8	M	L. forearm N/S	52 No lysis	R R
S. T.	1/10/52	26	F	Face N/S	3B/3C/55 No lysis	S S
J. W.	24/2/53	32	M	R. forearm N/S	3C/55 29	S S
J. W.	27/3/53	32	M	R. shoulder N/S	3C/55 29	S S
M. J.	24/6/52	11	M	Shoulder N/S	55 29	S S
C. C.	2/9/52	33	M	Back of neck N/S	52A No lysis	S R
F. H.	20/2/52	31	M	Neck N/S	71 No lysis	S R
W. R.	13/5/52	57	M	Groin N/S	52A 70	S S
W. R.	10/6/52	57	M	Shin N/S	52A No lysis	R S
C. B.	29/12/51	11	F	Leg N/S	52A 3B	R S
C. B.	14/11/52	11	F	Face N/S	52A 3B	R S

In the case of styes, where there is direct continuity with the anterior nares, 17 (77%) of the 22 patients carried nasal staphylococci. Moreover, the strains from the stye and the nose were identical in every case tested.

As Table III shows, there is a significantly higher nasal carriage rate in cases of styes—17 (77%) of 22—compared with 36 (51%) of 71 ($\chi^2=4.91$; D.F.=1; $0.02<P<0.05$).

Recurrent Staphylococcal Infections

A recurrence of infection was noticed in 16 (20%) of the 81 patients in this series. In 12 cases recurrence was observed after one to five months, in three cases after ten to fourteen months, and in one case after eighteen months. Some of this group of 16 patients had received a daily injection of 500,000 units of crystalline penicillin for five days.

As Table V shows, in every case of recurrent infection investigated the phage type of staphylococci recovered from the initial lesion was identical with that obtained from the subsequent lesion. It was concluded, therefore, that in the patient suffering from recurrent crops of boils or styes there

TABLE V.—Seven Patients with Recurrent Staphylococcal Infections

Case	Age	Sex	Date	Lesion	Phage
B. E. . .	12	F	5/1/52 12/1/52	Boil on forearm N/S Stye N/S	3C+ 3C+ 3C+ 3C+
I. P. . .	34	F	17/3/52 27/3/53	Stye N/S Boil on back of neck N/S	42E 42E 42E 42E
Y. S. . .	31	F	7/2/52 29/9/52	Boil on chin N/S Boil on leg	52A 52A 52A
C. B. . .	11	F	29/12/51 14/11/52	Boil on leg N/S Boil on face	52W 3B 52A
E. B. . .	19	F	29/1/52 31/3/52	Stye N/S Boil on upper lip N/S	3B 3B 3B 3B
P. B. . .	16	F	28/2/52 9/7/52	Boil on nose N/S " face	— — —
G. M. . .	22	M	29/12/52 27/4/53	Boil on back of neck N/S Boil on arm N/S	— — —

— Signifies no lysis by phages.

was a failure to eliminate a particular strain of staphylococcus rather than repeated fresh infections with strains of different phage types.

Case J. W.—A lorry driver aged 32 came to the surgery on February 24, 1953, with a moderate-sized boil on the right forearm. Boil—*Staph. aureus*, phage 3C/55, penicillin-sensitive; nasal swab—*Staph. aureus*, phage 29, penicillin-sensitive. He was treated with 500,000 units of crystalline penicillin systemically for five days and, in an attempt to prevent further boils developing, he was told to wash the whole arm with cetrimide 1% B.P., apply strong iodine solution to the area around the boil, and, after drying with a clean towel, to dust the whole arm with boric talc dusting-powder. In spite of this treatment he developed a second boil on the right upper arm on March 7. Boil: *Staph. aureus*, phage 3C/55, penicillin-sensitive; nasal swab: no staphylococci. On this occasion he was simply treated with kaolin poultice, but on March 27 he developed a third boil on the right deltoid region. Boil: *Staph. aureus*, phage 3C/55, penicillin-sensitive; nasal swab: *Staph. aureus*, phage 29, penicillin-sensitive.

In this case it was noteworthy that the nasal strain was different from the strain recovered from the boil, and that this strain persisted on the third occasion. The second boil developed in the absence of nasal staphylococci.

Case M. F.—A female student aged 27 came to the surgery on August 9, 1951, with a boil on the left elbow region and complained of recurrent boils. Boil—*Staph. aureus*, phage 42E. On October 9 she again presented with a boil on the left knee. Boil: *Staph. aureus*, phage 42E. She went to study in Oxford during most of 1952, but on September 29, 1952, she came again to the surgery with boils. Boil on right axilla—*Staph. aureus*, phage 42E; boil on right shin—*Staph. aureus*, phage 42E; nasal swab—*Staph. aureus*, phage 42E.

In this series of recurrent boils self-infection from a staphylococcal focus in the nose was not found to be of major importance. Of the 16 patients with recurrent lesions, six had an identical strain of staphylococcus in the lesion and nose, three had strains which were incapable of phage-typing, four had different strains in the nose and lesion, and three had no staphylococci in the nose. The last group of three patients with recurring lesions in the absence of nasal staphylococci are summarized briefly below. It will be seen that in the first case three attempts failed to show nasal staphylococci, and in the second case two attempts also failed.

Case M. K.—A man aged 30. September 3, 1952: boil on left forearm—phage 3C; nasal swab—no staphylococci. July 31, 1953: boil on right forearm—phage 3C; nasal swab—no staphylococci. October 13, 1953: boil on left elbow—phage 3C; nasal swab—no staphylococci.

Case E. H.—A woman aged 32. June 24, 1952: boil on breast—phage 52A; nasal swab—no staphylococci. November 26, 1952: boil on leg—phage 52A; nasal swab—no staphylococci.

Case A. C.—A boy aged 12 years. January 16, 1952—abdomen—phage 3C; nasal swab—phage 3C. July 7, 1952: abdomen—phage 3C; nasal swab—no staphylococci.

The size of the lesion and its associated constitutional disturbance appeared to have an effect in recurrence. As the case described below illustrates, a large boil or carbuncle may be followed in some patients by a prolonged period of freedom from boils.

A bus conductor aged 37 came to the surgery on July 30, 1953, with a boil in the right axilla. During 1941–2 he had suffered from very frequent crops of boils, but at the end of 1942 he developed a large carbuncle on the right forearm, and following this he had remained free from boils until the present infection.

Penicillin-resistant Staphylococcal Infections in General Practice

The incidence of penicillin resistance has been studied by doctors working in hospitals. Barber and Rozwadowska-Dowzenko (1948), for example, have reported that the incidence of penicillin-resistant strains of staphylococci was 14% in 1946, 38% in 1947, and 59% in 1948. No data were obtainable for infections in general practice, but comparative studies of in-patients and out-patients showed a lower incidence of resistant strains in the latter group (Forbes, 1949).

In the present investigation, 93 strains of staphylococci from the pus of boils and styes were tested at Colindale by the dried disk technique, and 23 (25%) were resistant to penicillin. Of 68 strains obtained from the nostrils of the same patients, 21 (31%) were resistant (Table VI). The phage patterns found in the resistant strains are shown in Table II. Twelve of the 23 strains belonged to Group I, and 8 of the remainder were resistant to phage lysis.

TABLE VI.—Incidence of Penicillin-resistant Staphylococci in 161 Strains from General Practice (Dried Disk Impregnated with 2 Units Penicillin)

Source	Penicillin-resistant
Boils (71) } Styes (22) } Nasal strains (68)	23 (25%) 21 (30.9%)
Total 161 ..	45 (28%)

In hospital series (Barber and Whitehead, 1949) a larger proportion of the resistant strains have been found to belong to Group III, although Williams *et al.* (1953) have also found a number of Group I strains. The low incidence of penicillin resistance in Group II strains confirms previous observations on hospital patients.

Forty-six strains in this series were also tested for sensitivity to chloramphenicol and chlortetracycline ("aureomycin"). No chloramphenicol-resistant strains were found, and the two strains which were chlortetracycline-resistant belonged to Group I. The emergence of resistance after a course of penicillin was noticed on one occasion.

Case W. R.—A man aged 57 developed a boil on the left groin on May 13, 1952. Boil—phage 52A, penicillin-sensitive; nasal swab—phage 70, penicillin-sensitive. He was treated with crystalline penicillin, 500,000 units daily for five days, but on June 10 he developed a boil on the shin. Boil—phage 52A, penicillin-resistant; nasal swab—no phage lysis, penicillin-sensitive.

In view of the previous findings in cases of recurrent infection, it was unlikely that the patient had a fresh infection with a resistant strain of 52A, and it was more probable that there was a change of sensitivity following a course of penicillin. In this case it was noteworthy that the nasal strain (of different phage type) remained penicillin-sensitive.

Indeed, the presence of penicillin-resistant staphylococci in the nostril of a patient with a boil or stye had little relation to the sensitivity of the strain isolated from the lesion. For example, three patients are described below who harboured penicillin- and phage-resistant staphylococci in their nostrils and yet developed infections with penicillin-sensitive phage-typable strains.

Case C. C.—Aged 33. Boil on back of neck—phage 52A, penicillin-sensitive; nasal swab—no phage lysis, penicillin-resistant.

Case T. B.—Aged 14. Boil on abdomen—phage 3C, penicillin-sensitive; nasal swab—42C, penicillin-resistant.

Case F. H.—Aged 31. Boil on neck—phage 71, penicillin-sensitive; nasal swab—no phage lysis, penicillin-resistant.

Conversely, patients were encountered who were suffering from penicillin-resistant infections and yet carried penicillin-sensitive nasal strains. *Case W. R.* showed this, and two further cases are described below.

Case R. E. H.—Aged 40. Boil on arm—no lysis, penicillin-resistant; nasal swab—no lysis, penicillin-sensitive.

Case C. B.—Aged 11. Boil on leg—phage 52A, penicillin-resistant; nasal swab—phage 3B, penicillin sensitive.

Epidemiology of Staphylococcal Infections

Although there have been many reports in institutional outbreaks of staphylococcal infections, only one account could be found of the spread of these infections within the home. Harrison (1948) described an outbreak of staphylococcal infection which occurred in a family of nine living under rather crowded conditions in an Oxfordshire village. In this family there were multiple examples of cutaneous infections; two children developed acute suppurative arthritis

and a third child developed acute osteomyelitis. The same phage pattern of staphylococcus was responsible for all three cases.

As stated at that time (*Lancet*, 1948): "This is a striking example of the epidemic potentialities of staphylococcal infections in the home, and it makes one wonder whether multiple staphylococcal infections of the skin in a household may not also be due to the spread of a single strain of staphylococcus from person to person. . . . In the home only the doctor can assess the part of the staphylococcus in family infections."

Without the phage method of typing, however, no reliable epidemiological study could be made, for the simultaneous development of two cases of staphylococcal infection in a household does not necessarily imply the spread of a strain from one to another. The following case illustrates this.

On February 20, 1952, a husband and wife both came to the evening surgery complaining of boils. The husband had a boil on the side of the neck, and his wife had a boil on the upper arm. Bacteriological studies showed: husband: boil on neck—phage 71; nasal swab—no staphylococci; wife: boil on arm—phage 52A; nasal swab, staphylococci not typable.

In this investigation it was possible to discover nine families in which there was spread of a single phage type of staphylococcus from person to person within the household (Table VII).

The immediate infectivity of a boil or stye appeared to be low, as only once did simultaneous lesions occur in other members of the household. In the other families the staphylococcus established itself so that over the course of months first one member and then another developed lesions with the same phage type of staphylococcus. No fewer

TABLE VII.—Nine Families with Multiple Staphylococcal Infections

Family	Name	Relationship	Age	Date	Lesion	Phage
1	E. G.	Mother	40	29/9/51	Boil on axilla	3B/3C
					N/S	3B/3C
	E. G.	Daughter	14	29/9/51	Boil on finger	3B/3C
					N/S	3B/3C
				21/4/53	Boil on axilla	3B/3C
					N/S	3B/3C
				21/4/53	Boil behind ear	3B/3C
					N/S	3B/3C
2	T. B.	Brother	14	22/3/52	Boil on abdomen	3C
					N/S	42C
	S. B.	Sister	2	19/6/52	Boil on buttock	3C/55
					N/S	55
3	S. T.	Sister	16	12/12/51	Stye left lid	3C/55
					N/S	3C/55
	L. T.	Brother	22	17/6/52	Boil on right knee	3C/55
					N/S	3C/55
4	J. T.	Son	13	15/2/53	Boil on back of neck	3C/55
					N/S	3C/55
	S. T.	Mother	30	18/5/53	Stye	3C/55
					N/S	3C/55
5	L. K.	Daughter	5	30/8/52	Stye	3C/55
					N/S	3C/55
	H. K.	Father	30	3/9/52	Boil on forearm	3C/55
					N/S	3C/55
6	M. M.	Father	25	14/5/53	Stye	3C/55
					N/S	3C/55
	B. M.	Daughter		28/8/53	Boil on buttock	3C/55
7	Y. S.	Mother	31	6/5/52	Boil on chin	52A
					N/S	52A
	M. S.	Daughter	13	19/4/53	Boil on leg	52A/79
					N/S	52A/79
	A. S.	Father	39	10/7/53	Boil on axilla	52A
					N/S	No staphs.
8	M. V.	Son	13	27/3/52	Boil on elbow	No lysis
					N/S	" "
	H. V.	Father	42	11/12/52	Boil on buttock	" "
					N/S	" "
	M. V.	Mother	44	14/1/53	Boil on finger	" "
					N/S	" "
9	C. B.	Sister	11	9/12/51	Stye	3B
					Boil on leg	52A
					N/S	3B
	E. B.	Sister	19	29/1/52	Stye	3B
					N/S	3B
P. B.	Sister	17	28/2/52	Boil on nose	No lysis	
M. B.	Sister	18	27/9/52	Stye	52A	
					N/S	52A

than 24 out of the 81 patients in this series were members of the nine "staphylococcal families" in which this case-to-case spread had occurred.

Discussion

A high nasal carriage rate of staphylococci occurs in normal people. Miles *et al.* (1944) in a summary of the literature until 1944, reported a rate of 27–47% in normal subjects, and later accounts give similar results (Martin and Whitehead, 1949; Barber *et al.*, 1949; Forfar *et al.*, 1953).

In the 71 patients with boils in the present study, coagulase-positive staphylococci were cultivated from nasal swabs in 48 (68%)—a rate which corresponded with that reported by Valentine and Hall-Smith (1952). On comparing the strains from the lesions and the nose in 25 of their cases they found them identical in every case. Tulloch (1954), who obtained similar results, claimed that "the nose is the primary source of infecting organisms in most cases of chronic staphylococcal dermatoses." This may be true of cases of sycosis barbae and impetiginous lesions of the face, but in this series of 71 patients with boils 23 (32%) carried no nasal staphylococci and 12 (17%) carried different strains in the lesion and nose.

Self-infection from a reservoir of staphylococci in the nose could therefore have occurred in only about 51% of cases of boils. Moreover, the elimination of the nasal strains (a difficult procedure) may not necessarily be followed by freedom from recurrences, for three cases were described with recurring infections in the absence of nasal staphylococci.

In the case of styes, however, where there was a higher nasal carriage rate and the strains from the lesion and nose were identical in all the cases tested, the nasal staphylococci probably played a more important part.

This difference was well illustrated in the following case.

December 29, 1951: Right stye—phage 3B, penicillin-sensitive; left stye—phage 3B, penicillin-sensitive; boil on leg—phage 52A, penicillin-resistant; nasal swab—phage 3B, penicillin-sensitive. November 14, 1952: Boil on face—phage 52A, penicillin-resistant; nasal swab—phage 3B, penicillin-sensitive.

Here the penicillin-sensitive strain (3B) present in the nose appeared to be responsible for the styes of both eyes (3B), but the boil was caused by a penicillin-resistant strain of different phage type (52A). When there was a recurrence of a boil nearly a year later it was caused by a similar strain to the original boil (52A), although the penicillin-sensitive strain (3B) was still present in the nose.

Recurrent Staphylococcal Infections.—In only about 51% of these patients with recurring lesions with the same phage type of staphylococcus was it possible to demonstrate a staphylococcal focus in the nose. The organisms may have been present over a wide area of skin around a boil, where they remained dormant for many months. The fact that most rigorous treatment of the skin with cetrimide 1%, strong iodine solution, and an antiseptic dusting powder still failed to prevent recurrence (Case J. W.) suggested that the staphylococci may have been present in the deeper layers of the skin.

In a small boil or stye the staphylococci probably exerted a feeble antigenic stimulus, which may have been still further reduced in cases which received systemic penicillin.

Summary

A clinical, bacteriological, and epidemiological study of 81 patients with boils and styes has been made in a practice on a housing estate in North London.

Forty per cent. of the patients were between 5 and 19 years and 50% were in the age group 20–44 years.

The eyelids, arms, face, and nose were the most common sites for boils.

Of 113 strains of staphylococci obtained from the pus of boils and styes, 96 (85%) could be phage-typed.

The preponderance of Group II strains among the penicillin sensitive staphylococci, which Rountree noticed in Australia, has been confirmed.

The total nasal carriage rate in patients with boils was 37–57% and in patients with styes 77%. In the case of styes the nasal strain and the strain from the eyelid were identical in 17 sets of cultures tested.

Of the cases in this series, 20% developed a recurrence of infection after one to twenty-four months. This recurrence was associated with the reappearance of the original phage pattern of staphylococcus and not a fresh infection with a different strain.

Multiple cases in a household occurred in 9 (11%) families. In these there was case-to-case spread of a particular phage type of staphylococcus.

Of 93 strains of staphylococci from the pus of boils and styes, 23% were penicillin-resistant. These resistant strains were mainly in Group I or were unsusceptible to phage-typing. Two chlortetracycline-resistant strains (both Group I) were encountered in 46 strains.

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PRIMARY TUBERCULOSIS OF THE LUNG

ANALYSIS OF 298 CASES OF PRIMARY COMPLEX SEEN IN A CHEST CLINIC (1948–51)

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The study of primary tuberculosis is both important and interesting, and the literature dealing with it is extensive. While the primary lesion can occur at any site in the body, 90% of these lesions are found in the lungs (Miller, 1952). Conversion of the tuberculin reaction from negative to positive is normally uneventful, but the literature on the subject mainly concerns cases in which conversion is accompanied by symptoms and signs severe enough to warrant admission to hospital. Although Schlesinger (1953) quoted a mortality of 14% of 400 cases admitted to the Hospital for Sick Children, Great Ormond Street, between 1945 and 1953, he stressed that a large group could be treated and supervised as outpatients. This paper is concerned with cases of primary tuberculous infection seen at the Swansea Chest Clinic