DIPHTHERIA IN SOUTH PERSIA

BY

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As we have been unable to trace any significant reference to diphtheria in Persia we give an account of the 48 cases which we encountered from January 1, 1948, to September 30, 1949, on Abadan Island, South Persia.

The island lies in the Shatt-el-Arab estuary, at the head of the Persian Gulf, is 25 miles long, and is 6 miles wide at its broadest point. The rivers Karun and Bahmanshir separate it from the mainland. Apart from a marginal belt of date palms it is a flat desert, nowhere more than 10 ft. (3 metres) above the level of the river. From May to the end of September it is extremely hot, with a maximum shade temperature ranging from 100° F. (37.8° C.) to a peak of 120° F. (48.9° C.) in June. The summer humidity is rarely above 30% before August, when the south wind from the Gulf raises it to 50%. The winter is cool, with occasional torrential rain-storms, providing the annual rainfall of 15–20 in. (38–51 cm.). The minimum night temperatures in winter fall to 33° F. (0.55° C.), but the summer nights have a minimum of around 93° F. (33.9° C.).

The population is about 200,000, and consists mainly of non-immunized Persians. The foreign elements fall into three groups: the British staff of the oil company and their families, numbering about 5,000; the Indians and Pakistanis, about 1,500; and a continually changing shipping population of about 1,000. At least 120,000 of the Persian population are either employed by the oil company or are members of the families of employees, the company assuming responsibility for their medical care. Cases of infectious disease arising among the remainder are received at the Company Isolation Hospital. It is therefore reasonable to assume that most of the cases of diphtheria are seen and treated. Mild cases of course may, as elsewhere, pass unnoticed.

Four or five ships enter and leave the port daily, coming from all parts of the globe, so that in theory infection may be introduced from any country. The travels of members of the staff on leave offer further possibilities. With its numerous outside contacts, therefore, it is probably not a suitable area on which to assess the incidence of the disease in South Persia as a whole, the inland areas being less open to the introduction of new strains.

The company's laboratory at Masjid-i-Suleiman, 130 miles inland, is the only other major source of information available to us. The records of the two laboratories (Table I) suggest that the disease was a rarity before 1948,

TABLE I.—*New Cases Reported After Isolation of C. Diphtheriae*

	At Abadan	At Masjid-i-Suleiman
1941	1	2
1942	2	4
1943	3	3
1944	0	0
1945	3	0
1946	0	3
1947	2	0
1948	24	3
1949 (9 months)	17	4

The cases at Masjid-i-Suleiman are not referred to below, and are not included in the total of 48.

but shortage of staff, both laboratory and medical, and restricted equipment probably give a false impression of the war years.

Bacteriology

Before 1948 the diagnosis was made on films from an 18-hour culture on Löffler's inspissated serum, using Neisser's stain. The isolation of pure cultures was in consequence difficult, but several of the strains obtained proved virulent. In 1948 the following routine procedure was adopted.

The swab is inoculated on Neill's tellurite agar and on unheated rabbit-blood agar. A film is then made and Gram-stained, Vincent's organisms and *Oidium* being reported if present, but no opinion being given on the presence or absence of *Corynebacterium diphtheriae*. The two plates are examined after 18 hours' incubation, haemolytic streptococci being confirmed by stained films and a "rake through" film being stained by methylene blue to exclude *C. diphtheriae*. The blood plate is discarded, and the tellurite is examined again at 36 hours.

Colonies appearing to be *C. diphtheriae* on tellurite and showing bacillary forms with multiple bars in a methylene-blue film are reported immediately as "positive." Coccil forms giving colonies resembling mitis diphtheria have often been encountered. Subcultures from tellurite to heated blood agar and from that to Hiss's serum-water sugars and Hartley's broth have been made in all cases. Finally, an 18-hour culture on Löffler's serum is suspended in 2 ml. of distilled water and inoculated into the axilla of a guinea-pig weighing less than 250 g. Death of the animal in two days or less, with characteristic post-mortem change, has been accepted as evidence of virulence. When the animals are alive and well at the fifth day the strains have been reported as avirulent. Control guinea-pigs, immunized with antitoxin immediately before inoculation with living cultures, have not been used. The rapid death of the animals, with the post-mortem changes seen in guinea-pig diphtheria—namely, gelatinous exudate at the site of inoculation and in the pleural cavities, with haemorrhagic change in the suprarenals—does not seem to leave any doubt regarding the virulence of the organism.

Types Encountered

The gravis type has been reported twice. Each strain gave a large "daisy-head" grey colony on tellurite, a "ground-glass" growth on heated blood agar, with characteristic morphology in a stained film, fermented glucose, and starch, but not saccharose, and was virulent for the guinea-pig. Growth in broth gave a deposit with clearing of the medium but no pellicle formation.

The mitis type has been reported 39 times. The colonies were from 1.5 to 3 mm. in diameter, smooth, shining, with a central papilla and an uninterrupted margin. Stained films gave a characteristic morphology. Glucose was fermented, but not starch or saccharose. All but two strains were "virulent" for the guinea-pig. One of these was isolated from the throat of a fatal case and the other from a symptomless individual in a household where a proved case had occurred. In only four cases has growth in broth given a uniform turbidity. The rest showed a granular appearance combined with turbidity and a certain amount of deposit. Growth on heated blood agar gave a "ground-glass" appearance, and in no case was any green formation noted about the colonies. Five strains were cultured on the special chocolate agar recommended by Gordon and Higginbottom (1942), but none of them showed any green formation in the medium.

The intermedius type has not been encountered.

Haemolysis.—In all cases in which haemolytic colonies have been observed at 18 hours on the unheated rabbit-blood agar, films have shown the colonies to be a streptococcus. Five mitis strains, tested by the method of Hammerschmidt, quoted by Anderson *et al.* (1931), showed haemolysis. To 1 ml. of a 48-hour culture in broth was added 1 ml. of 1% washed human red blood cells; this was then incubated two hours, placed overnight in the cold, and then read.

Clinical Features

In Table II the bacteriological "positives" and also seven cases with convincing clinical evidence of the disease are shown. Further reference to the latter group will be made.

TABLE II

	Recovered	Died	Fate Unknown	Total
Clinical diphtheria: positive swab	20	7	—	27
Symptoms slight: positive swab. Presumed carrier	4	—	—	4
Clinical diphtheria: positive swab. Not admitted	—	—	7	7
Swab positive: no clinical record	1	2	—	3
Clinical diphtheria: no swab, or swab was negative	3	4	—	7
Total	28	13	7	48

The seven cases "not admitted" were children brought to the non-employee clinic; a swab was taken and the parents were told to bring the children the next day. When the parents fail to do this it is virtually impossible to locate the patient. It is fairly easy to find an employee by his personal number, but finding "Ali the son of Mohammed who lived at the house of Yadollah" is an insuperable obstacle.

The seven cases included on clinical grounds were all children between 2 and 4 years, admitted at a late stage of the disease, with extensive membrane formation, toxæmia, cyanosis, and laryngeal obstruction.

The age incidence of Iranian patients is shown in Table III.

TABLE III.—Incidence of Iranian Patients

Age (Years)	Died	Recovered	Carriers	Total
0-2	4	0	0	4
3-5	7	12	0	19
6-20	1	8	1	10
Over 20	0	2	2	4
Total	12	22	3	37

The four British cases were all adults. Two men, aged 26 and 28, one with a little tonsillar membrane and the other with none, had a mild sore throat with fever. A woman aged 30 was affected equally mildly. All three recovered rapidly. The fourth patient, a woman of 31, was in a desperate condition, with massive membrane formation, respiratory obstruction, "bull-neck," and toxæmia within 24 hours of the onset of symptoms, death occurring ten days later. These four were all mitis infections.

Table III indicates clearly that the disease is most severe below the age of 5. Nearly half the children died, and those who recovered were extremely ill with toxæmia and extensive membrane formation. Delay in obtaining medical attention was evidently largely to blame for the fatalities. Three of the "under 2" group had been ill for three, six, and nine days, and one fatal case in the 3-5 year group had been ill for 10 days. Included also in the latter group

are the three fatal "unproved cases," quoted in Table II, which were in such a desperate state that death occurred a few hours after admission. Similarly, the fatal case in the 6-20 age group was that of a boy of 7 who had been ill four days and who on admission was drowsy, vomited repeatedly, and had a liver enlarged three fingerbreadths.

Concurrent Infections.—In one case Vincent's organisms were present, in five cases a haemolytic streptococcus, and in two cases both haemolytic streptococcus and Vincent's organisms.

Other Throat Infections.—During the period under review the total number of swabs cultured, other than "follow-up" swabs of diphtheria and swabs of contacts, was 805. The positive findings were:

<i>C. diphtheriae</i>	..	..	..	41
Haemolytic streptococcus	..	..	..	191
<i>Staphylococcus aureus</i>	..	..	..	70
Vincent's organisms	..	..	..	50
Pneumococcus	..	..	..	11
<i>Bact. coli</i>	..	..	..	9
Pneumobacillus	..	..	..	2
<i>Oidium albicans</i>	..	..	..	2

Acute streptococcal throat seems to be about five times as frequent as diphtheria, and the pneumococcus is notably rare.

Summary and Conclusions

Forty-eight cases of diphtheria occurring in a large Persian community in Abadan, South Persia, since January, 1948, are described. The incidence of the disease is far less than in European countries, despite a non-immunized community. Infections are predominantly of the mitis type and relatively mild in adults. There is a high mortality rate in children below the age of 5, mainly because of delay in obtaining medical advice, and the need for preventive measures seems to be in infancy rather than in children of school age.

The incidence of other throat infections is recorded, and shows acute streptococcal throats to be about five times as frequent as diphtheria.

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REFERENCES

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Discussing the treatment of injured miners underground, the Report of H.M. Chief Inspector of Mines for the year 1948 says: "All that happens, down to the smallest detail, to a seriously injured person in the period immediately following an accident may well determine whether the injury received is to result in least disability or something more than that. If the injured person is fortunate there is (i) a competent first-aid man, (ii) the necessary equipment, and (iii) both of these near at hand. The efforts of those whose responsibility it is to organize first-aid at mines must be directed to establishing and maintaining these components of what has been termed the *Essential Trinity* of an efficient first-aid service. The first-aid equipment available to an injured man depends upon effective distribution. This has been greatly facilitated by the increased use of tubular first-aid containers. Their use has now become more widespread, and one division alone has ordered over a thousand of them. Contributing also to the improvement that has been noticed in the distribution of first-aid equipment has been the adoption by managements of what has come to be known as the '250-1,000-250 yard rule' to govern the distribution of first-aid stations below ground. Its observance requires that there shall be a first-aid station within 250 yards of the shaft bottom, within 250 yards of the face, and at intervals not exceeding 1,000 yards along the main roadways on which men work or travel."