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COMMENTS ON SEWAGE CONTAMINATION OF COASTAL BATHING WATERS

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INTRODUCTION

The findings by the Committee on Bathing Beach Contamination of the Public Health Laboratory Service[1] have given rise to comment by various coastal authorities. Health authorities find it difficult to convince city councils of the potential dangers.

The presence of the sea offers an almost irresistible temptation to seaside municipalities to dispose cheaply therein the sewage of the community.

THE DANGER OF DISCHARGE OF EFFLUENTS INTO THE SEA

Sea or estuary water receiving raw waste water may be dangerous: (1) In coastal areas where there are mussel beds and in estuaries where oysters are cultivated, and, (2) on beaches, especially in bathing areas.

In both the above cases, the pathogenic bacteria are mainly, though not exclusively, salmonellae. To give a sufficient degree of safety, purification in sea water must be rapid enough to destroy the bacteria in a few hours (and in a shorter time if the outfall is particularly near to the important points). Available literature pays little attention to this aspect of the problem. It seems clear that direct discharge of waste water into the sea is bacteriologically objectionable; in practice the most important requirements are to know its effects on public health.

1. *Shell-fish Beds*

A tolerant attitude cannot be allowed and standards must be severe. The literature contains many reports of the presence of salmonellae in edible shell fish such as mussels, oysters, cockles and clams.

Brisou[2] says that the number of cases of salmonellosis due to shell fish is very high. At Toulon, mussels from polluted sea water caused 14 cases in less than 6 months. The reason for this high infectivity rate in molluscs is obvious; they actually concentrate pathogenic organisms.

Belin[3] in 1934 estimated that during the previous 15 years more than 100.000 cases of typhoid fever, of which 25.000 had ended fatally, occurred in France due to the consumption of shell fish.

Roos[4] found that an epidemic of infective hepatitis in Sweden was caused by oysters. He further states that waste water should be treated sufficiently to destroy all pathogenic microbes and even viruses.

2. *Sea and Estuarial Bathing Places*

A report in 1940[5] by a joint committee on bathing places of the Association of Public Health of America and the Conference of State Sanitary Engineers, expressed the view that there was surprisingly little evidence in support of infection through bathing. In a progress report of the same committee in 1952[6] on an investigation in Chicago, no noticeable correlation was found between the coliform counts of bathing waters of two beaches and illness among the bathers.

Steiniger[7] reports that no paratyphoid infections had been traced to bathing in the harbour of Husum, although *S. paratyphi B* could be isolated regularly in large numbers from the water and the silt of the harbour in which vast numbers of people bathed every summer.

Buttiaux and Leurs[8] state that in the neighbourhood of the North Sea Beach, where they found *S. montevideo*, no case of disease attributable to it had been reported for 3 years. Buttiaux[9] concludes that the transmission of salmonelloses by immersion and bathing in polluted sea water is therefore possible but apparently exceptional. He continues by stating that amongst the virus diseases, especially poliomyelitis and infective hepatitis, there is little convincing evidence for the part played by bathing places in the spread of virus diseases, and none at all relating to sea water.

Winslow and Moxon[10] at New Haven, Connecticut, found that most of 61 typhoid cases which occurred in the area during 1921 - 1922, were attributed to bathing in this area.

A series of infections with *S. paratyphi B*, which occurred at a seaside resort in North Devon every summer between 1943 and 1946, concentrated local attention on a very unsatisfactory sewage outfall. At this resort sewage is discharged into the sea at all stages of the tide, frequently causing fouling of the adjacent beach. This initiated the survey of beach pollution by Moore.[11] The outbreaks were eventually traced to a carrier, but in at least 2 or 3 of the cases Moore considered that the illness was almost certainly due to beach infections.

In 3 districts served by the Exeter laboratory, where sporadic cases of paratyphoid and typhoid fever have occurred regularly during the past 10 years, Moore, Perry and Chard[12] found that there was a common epidemiological factor in the lack of an adequate barrier between the local population and sewage from the area. In 2 of the areas there was an unsatisfactory sewage outfall and in the third a polluted river from which water was drawn for watering allotments.

Moore suggests that in an endemic enteric district — and it is worth-while noting that enteric is endemic in South Africa — where the local population is not completely protected from contact with sewage, it is safer to assume that this contact plays a direct or indirect part in maintaining the endemic infection in the area, and that steps should be taken to lessen the chances of exposure to potential infection.

Boyer and Tissier[13] point out the rarity of cases of poliomyelitis in which a bathing place can be incriminated.

The examples mentioned above illustrate the danger

to the public health in communities in which both carriers and subclinical infections occur.

The Committee on Bathing Beach Contamination,[3] in an exhaustive study on the contamination of bathing beaches in England and Wales (and it is important to note that this study was carried out in England and Wales), came to the conclusion that:

1. Bathing in sewage-polluted sea water carries only a negligible risk to health, even on beaches that are aesthetically very unsatisfactory.

2. The minimal risk attending such bathing is probably associated with chance contact with intact aggregates of faecal material that happen to have come from infected persons.

3. The isolation of pathogenic organisms from sewage-contaminated sea water is more important as evidence of an existing hazard in the populations from which the sewage is derived, than as evidence of a further risk of infection in bathers.

4. Since a serious risk of contracting disease through bathing in sewage-polluted sea water is probably not incurred unless the water is so fouled as to be aesthetically revolting, public-health requirements would seem to be reasonably met by a general policy of improving grossly insanitary bathing waters and of preventing as far as possible the pollution of bathing beaches with undisintegrated faecal matter during the bathing season.

In answer to (1) above, attention should be drawn to the difference in carrier rates in England and South Africa. In New York State, exclusive of New York City, Ames and Robins,[14] in 1943, calculated that in 1940 there were about 42 typhoid carriers per 100,000 population. According to them, the rate in Great Britain is probably not more than 2 per 100,000 population. In South Africa the true numbers of carriers of *S. typhi* is still very doubtful. It was estimated by Cluver[15] in 1946 that 2% of the Bantu population were carriers. The only other estimate that could be found was that of Bokkenheuser,[16] namely about 0·1%. Bokkenheuser[17] is inclined to believe that this figure might be lower, namely 0·05%. He adds that there may be a considerable number of subclinical cases which recover spontaneously. Thus it would appear that the carrier rate lies between 100 and 2,000 per 100,000 population.

Loubser[18] put the possibility of typhoid fever being treated as a normal gastro-intestinal disturbance as very high. This statement suggests that the above claims for South Africa might well be conservative estimates.

Under (2) in the above Committee's conclusions, the South African figures would mean that the chances of the sea water containing intact particles with viable salmonellae originating from chronic carriers of *S. typhi*, would be about 50 times greater than in Great Britain. To this must be added an unknown but probably highly significant contribution from undetected cases of subclinical typhoid infections, since the disease as measured by notification rates is about 60 times more prevalent than in Great Britain.[19]

In (3) it is stated by the Committee 'that the isolation of pathogenic organisms from sewage-contaminated sea water is more important as evidence of an existing hazard in the populations . . .'. This conclusion must be read in conjunction with point (5) in their summary, where they state that *S. paratyphi B* were isolated from 13·3% to 40·1% of sea-water samples examined. These rather high percentages of positive isolations are qualified by the further statement that 'comparison of the numbers of salmonellae isolated with what is known of the minimum infective doses of these organisms, suggested that very large volumes of sea water would require to be ingested for infection to occur'.

The minimum infective dose of salmonellae would vary considerably, but Kehr and Butterfield[20] estimated that about 1 out of every 50 persons who ingests a single *S. typhi* actually contracts typhoid fever. On this basis they calculated the chance of a person contracting typhoid during a 90-day season as being 1 in 950 for the daily swimmer, i.e. with a typhoid-morbidity rate in the population of 4 per 100,000. All being equal, in South Africa (with a conservative estimate of the sea water being say 100 times more infected) the chances would be 1 in 28·5 for the daily swimmer in a 30-day period.

Streeter[21] in North America, quoting Wolman, Gorman, Eliassen and Cummings, estimated that the morbidity rates of water-borne diarrhoea-enteritis averaged about 20 times those of typhoid fever. If this ratio is applied in South Africa to the typhoid risk along the coast for the individual daily bather, his chances of contracting diarrhoea-enteritis during a 30-day season would be 1 in 1·42 provided the concentration of sewage is similar.

Under (4) in the conclusions of the Committee on Bathing Beach Contamination, certain reservations are still held by stating that, 'since a "serious" risk of contracting disease of bathing in sewage-polluted sea water . . .'. In this conclusion they probably could not overlook point (7) in their summary where they state that 4 cases of paratyphoid fever due to bathing were recorded. The Committee must also have had in mind the cases of paratyphoid and typhoid fever, quoted in their own literature survey, contracted from paddling and bathing in contaminated sea-bathing places and drinking from polluted streams. This conclusion further states that 'public-health requirements would seem to be reasonably met by a general policy of improving grossly insanitary bathing waters and of preventing so far as possible the pollution of bathing beaches with undisintegrated faecal matter during the bathing season'. Koch[22] found that sewage effluent could travel hundreds of yards without dilution and that faecal particles were protected from coming into contact with either the air or surrounding water. He goes on to say that where a shore is inhabited or has been developed as a bathing place, or has shell-fish beds on it, the protection it derives merely from the remoteness of a polluted discharge, even if the prevailing winds are favourable, is highly doubtful.

The question arises: what would be a safe limit to establish a sewer outfall and, since Aglitskii and Khair[23] noted contamination of sea water 3,000 metres from the outfall, grave doubts arise about the habit of some coastal authorities who allow the discharge of effluents into the surf zone along the South African beaches.

The next question is what constitutes undisintegrated faecal matter? Taking into consideration that a carrier excretes from 1,000,000 up to 12,000,000,000 salmonellae per gram of faeces, it is obvious that particles which could

afford bacteria protection from sea water could harbour thousands of these bacteria and be invisible to the naked eye.

The Committee state in their summary that 'a statistically controlled study of the bathing histories of 150 poliomyelitis cases in children living permanently by the seaside gave no evidence that bathing had played a part in causing the disease'. This conclusion would have been valid if it had been compared with the case histories of holiday children from inland who had contracted the disease after leaving the seaside resort. The children living at the seaside and continually being exposed to infection of the virus could have an acquired immunity, and this would support the above conclusion.

Lack of information and uncertainty about the mode of infection still prevail for many viral diseases. This encourages caution when establishing standards based on any of the present-day accepted indices of contamination. Gilcreas and Kelly[24] have shown in laboratory experiments that at water temperatures of 8 - 10°C. the persistence of Theiler and Coxsackie viruses is much greater than that of a laboratory strain of *E.coli* (which has a higher resistance than a natural strain).

The Committee found that in only a few instances could *Staphylococcus aureus* be isolated from sea water, since this was the only nasopharyngeal organism for which adequate enrichment media were available. Their epidemiological inquiries thus exclude the incidence of ear, nose and throat diseases due to bathing in sewage-polluted sea water.

The fact that no *Mycobacterium tuberculosis* or *Mycobacterium balnei* organisms were isolated in the sea water investigated in England and Wales, would not exclude the possibility of finding them in South African waters, due to the higher incidence of tuberculosis in South Africa, especially amongst the Bantu population.

CONCLUSION

In the light of the available information, there is considerable doubt as to the validity of the Committee's findings when applied to South African conditions.

The CSIR is following up details about the rather adverse reception this report had in medical circles in the United Kingdom.

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