

# Cholera Case Investigation and the Detection and Treatment of Cholera Carriers in Hong Kong \*

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*Between 1961 and 1966 cholera cases occurred in Hong Kong in each year except 1965. During this period each case was extensively investigated in order to detect carriers among the contacts.*

*In 1961 investigations were confined to the home of the patient but it was found that a much more extensive investigation was required to get epidemiological information of real value. From 1962 onwards the investigations were extended to include the patient's place of employment or school and any eating-place visited by the patient in the 7 days before the onset of disease.*

*Detection of carriers has been a relatively simple procedure in Hong Kong as it has been the policy to isolate all contacts of a cholera case in a quarantine centre. In 1961 three rectal swabs were taken to detect carriers; this was increased to 5 in 1962 and now 7 consecutive daily swabs are considered necessary. Oral streptomycin is regarded as the best treatment for carriers because it is relatively cheap, it produces no side-effects, treatment can be completed in one day and vibrio resistance to the drug is unlikely.*

*As detailed case investigation is expensive, however, it should be undertaken only if the object is to determine the source of the infection. This object was achieved in Hong Kong on only 6 occasions during the period under review. Isolation of the contacts was of little value in comparison with the disruption of family life and the expense involved. Although regular nightsoil sampling was a good indicator of the presence of the disease, the back-tracing of positive samples occupied facilities and staff which could have been better used in case investigation.*

The existence of the carrier state in cholera is now well recognized (Pollitzer, 1959), and many classifications of carriers have been made depending on their relationship to a particular case or their epidemiological significance (Kamal).<sup>5</sup> It is now established that the carrier state is usually of short duration (Felsenfeld, 1966), and that the excretion of vibrios is intermittent (Forbes, 1965); in certain circumstances, however, a chronic carrier state can exist (Dizon, 1965). There is as yet no general agreement on the role the carrier plays in the spread

of cholera or on what measures should be taken to investigate cholera cases or to detect and treat carriers.

Since 1961, when cholera first appeared in Hong Kong, all family and domestic contacts have been admitted to an isolation centre for investigation and since 1962, when epidemiological investigations became more detailed, "community", "workplace" and "eating-place" contacts have also been isolated if preliminary investigation has shown that infection has been or may have been present amongst these groups. Once carriers have been detected treatment is given with oral streptomycin as the drug of choice.

This paper describes in some detail the methods used in Hong Kong to investigate cases and to detect carriers among contacts, and outlines the treatment given to 221 carriers found between 1961 and 1964. Table 1 gives the numbers of cholera cases, contacts, carriers, and the number of deaths which occurred in Hong Kong between 1961 and 1966.

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have been present in these groups. The eating habits of the patient in the 7 days prior to the onset of illness must also be included in the case-history.

To complete the investigation at the home of the patient it is necessary to:

(1) confirm from neighbours and relatives that the patient lived at the reported address;

(2) prepare a sketch map of the patient's home, showing the sleeping place of each resident, cooking and toilet facilities, and water supply;

(3) take bacteriological swabs from all moist surfaces in the home;

(4) collect specimens of food and water for bacteriological investigation;

(5) obtain from relatives further information about the patient's habits and movements;

(6) trace missing contacts who may be at school or work;

(7) compile a list of all contacts living in the home of the patient;

(8) transport contacts to an isolation centre;

(9) disinfect the patient's home and dispose of water and perishable food;

(10) arrange for care of domestic pets and livestock;

(11) post a quarantine notice and lock up the home.

If evidence is present that the patient may have contracted cholera at a restaurant or other eating-place, a detailed investigation must be undertaken similar to that outlined above. Before the workers are isolated and the eating-place closed, however, proof of infection should be obtained by rectal swabbing of the staff and bacteriological examination of the premises.

#### DETECTION OF CARRIERS

Experience in Hong Kong has indicated that the number of carriers detected during a cholera outbreak bears no relation to the degree of infection in the community. In fact the number of carriers found among the contacts of a cholera case is directly proportional to the number of consecutive daily bacteriological examinations made (Van de Linde & Forbes, 1965; Forbes et al., 1967). Rectal swabs have always been preferred to stool specimens in Hong Kong as the procedure is quicker and is the

only way in which the investigator can be certain from whom the specimen came.

In 1961 the number of rectal swabs taken from contacts of cases varied from 1 to 3 while 3 post-treatment negative swabs were considered sufficient to determine cure. However, it soon became evident that this routine was inadequate and in 1962 the number of both diagnostic and post-treatment swabs was increased to 5, at daily intervals. Subsequently, in 1963 the number of diagnostic swabs was increased to 7. Some of the results of the carrier detection procedures in individual outbreaks are now discussed separately and these are followed by an analysis of the over-all results.

In 1961, 53 carriers (7.1%) were detected from the 748 isolated contacts of 72 of the 77 cases which occurred (the remaining 5 cases had no known contacts). As stated previously, during this year only "domestic" contacts of cases were isolated and the more extensive investigations of subsequent years were not undertaken. Only 1 rectal swab was taken from 422 of the 748 contacts and 19 carriers were revealed; 24 carriers were revealed from among 134 contacts who had 2 rectal swabs and 10 carriers were revealed from among 192 contacts who had 3 rectal swabs.

The most interesting finding (Luk, 1965) relating to carriers in 1961 was that from the 148 contacts who lived on boats 35 carriers were detected, a carrier rate of 23.6%, while only 18 carriers were found in the remaining 600 contacts, a rate of 3.0%. In other years similar findings have indicated that the lower the socio-economic status the greater is the number of carriers found among contacts. The probability of infection spreading to contacts appears greatest under overcrowded and unhygienic circumstances.

As only 11 cases were notified between the end of August and mid-October in 1962 a more extensive range of epidemiological investigations was possible. From the 120 isolated contacts of 8 of the 11 cases which occurred (3 cases had no known contacts) 20 carriers were detected (16.6%).

One case which occurred in a small village in the New Territories is of particular interest in that it demonstrated quite clearly that infection could be widespread in a community without an outbreak of the disease occurring. In this village of over 400 persons, there were 4 distinct social groups with little close association between them. When the patient was admitted to hospital, 5 immediate family contacts were isolated. At the same time the whole

village population was subjected to daily rectal swabbing on a voluntary basis and all except a very few known residents were examined. Altogether 16 carriers were detected and all of them had close associations. This epidemiological pattern suggested a common source but no positive results were obtained from samples of water or food. The only common feature was close proximity at play or in the home and the most probable means of spread was by person-to-person contact.

From the 1979 contacts of 108 of the 115 cases which occurred in 1963 (7 cases had no contacts), and from the 231 residents of 10 premises which were traced as sources of infection by nightsoil sampling, 119 (5.4%) carriers were detected.

This year's investigations demonstrated the importance of obtaining a clear picture of cholera patients' eating habits and the necessity of an extensive examination of a restaurant considered to be a possible source of infection.

On 3 separate occasions the source of infection was traced to eating-places which patients had visited. The most important of these incidents was associated with a modern 4-storey restaurant in the North Kowloon area. Between 26 September and 12 October, 17 cases were considered as having contracted cholera, either directly or indirectly, from this restaurant. Five cases were among people who had eaten food there, 4 cases were among people who had bought food at the restaurant and eaten it at home, and 8 cases were family contacts of people who had eaten at the restaurant. Of the 105 persons employed at this place 34 were found to be carriers. Only 12 of these 34 carriers were detected on the first rectal swab while 9 were detected on the second swab, 7 on the third, 3 on the fourth, 2 on the fifth, none on the sixth, 1 on the seventh, and none on the eighth.

Bacteriological examination of the premises revealed that heavy contamination was present only in the toilet area. No source of infection, other than the presence of the large number of carriers, was found and therefore spread of infection must have been by contaminated food or by direct person-to-person contact. At the time of this outbreak a very heavy nightsoil infection was demonstrated in North Kowloon, indicating that although only 17 cases were positively linked with the restaurant, there were possibly many hundreds of associated subclinical infections and carriers in the area.

A total of 26 carriers was detected in 1964 from the 391 isolated contacts of 32 of the 34 cases which

occurred (2 cases had no known contacts). In addition, 3 carriers were detected by the follow-up of nightsoil infections but their contacts were not isolated. The carrier rate of case contacts was therefore 6.6%.

Altogether 16 of the cases of cholera which occurred between 11 May and 20 May were traced to a common source, a restaurant, and the particular source of infection was established as well-water. This was the only occasion in Hong Kong during the present pandemic that water was definitely established as a source of infection. This restaurant was closed after it was found that 18 of the 46 employees (40%) were found to be carriers and that cholera organisms were cultured from virtually every moist surface in the premises. The source of infection was found to be an illegal water supply drawn from a well in the yard; seepage into the well had occurred from an adjacent defective water closet.

Only 9 of the 18 carriers were detected following the first rectal swab while the remainder were detected after subsequent swabbing, a pattern which has been mentioned previously.

Heavy nightsoil infection in the area of this restaurant was also found, indicating the rapid dissemination of subclinical infections and carriers from a central source.

In 1965 and 1966 only 1 case of cholera was notified and only very occasionally were nightsoil infections reported. No carriers of any kind were discovered during this time.

Table 2 shows the number of cases, the number of contacts isolated or quarantined, and the number of carriers detected among these contacts. The percentage of cases with carriers among their contacts varied from 21.8% to 34.7%. It would appear that this percentage decreases as an epidemic progresses. For example in 1963, of the first 50 cases with contacts, 21 (42%) had associated carriers while of the last 58 cases only 12 (20.7%) had carriers. In 1964 a similar pattern was present when 5 (62.5%) of the first 8 cases with contacts, and 2 (8.3%) of the remaining 24 cases with contacts, had associated carriers. The possibility exists in Hong Kong that, in the later stages of a cholera outbreak, patients with symptoms seek treatment at an earlier stage and before infection has had a chance to spread to contacts. From Table 2 it is also seen that the carrier rate among contacts varied between 5.4% and 16.6%. The highest rate, in 1962, was accounted for by the number of carriers who were discovered by taking rectal swabs from the whole popula-

TABLE 2  
RELATION BETWEEN THE NUMBERS OF CHOLERA CASES, CONTACTS AND CARRIERS

Year	1961	1962	1963	1964	1965	1966	Total
No. of cases	77	11	115	34	—	1	238
No. of cases with contacts	72	8	108	32	—	1	221
Cases (with contacts) associated with carriers	No.	25	2	33	7	—	67
	%	34.7	25.0	30.6	21.9	—	30.3
No. of contacts	748	120	2 210	391	—	4	3 473
Carriers among contacts	No.	53	20	119	29	—	221
	%	7.1	16.7	5.4	7.4	—	6.4

tion of a village, but without isolating or quarantining all of them. The percentage of carriers detected in 1963 and 1964 was greater than it would have been if the number of carriers detected from infected restaurants had been excluded. In general, it can be stated that between 20% and 30% of cases will have carriers detected from their contacts while approximately 6% of all contacts will be carriers.

The data for the age and sex distribution of the 221 carriers detected between 1961 and 1966 show that whereas, in 1961, 77% of the carriers were under 20 years of age, in 1963–64 only 42% were under 20 years of age, and 35% were aged between 20 years and 40 years. This difference is partly explained by the inclusion of the two groups of restaurant employees during 1963–64 who fell into the higher age-groups. Except in 1961, the number of males was greater than the number of females and this is also accounted for by the inclusion of restaurant employees.

Table 3 gives a classification of carriers by type. The classification used here may not be acceptable in territories with social conditions which are different from those in Hong Kong but it has been useful in our epidemiological investigations. In 1961 the largest number of carriers was detected among family contacts and this was due to the fact that 22 of the 77 cases notified occurred in people living on sampans in single family units with their lower hygienic standards. In 1962 "community" carriers outnumbered others but they all related to one case in the New Territories. In 1963–64 "restaurant" carriers were most numerous and underline the importance of investigating the patients' eating habits.

TABLE 3  
NUMBER OF CARRIERS DETECTED BY TYPE AND BY YEAR

Type of carrier	1961	1962	1963	1964	1965	1966	Total
Family <sup>a</sup>	47	2	35	5	—	—	89
Domestic <sup>b</sup>	6	4	26	2	—	—	38
Community <sup>c</sup>	—	14	4	—	—	—	18
Restaurant <sup>d</sup>	—	—	39	19	—	—	58
Nightsoil <sup>e</sup>	—	—	14	3	—	—	17
Miscellaneous	—	—	1	—	—	—	1
Total	53	20	119	29	—	—	221

<sup>a</sup> Family carriers = those directly related to the patient.

<sup>b</sup> Domestic carriers = those who lived in the same premises as the patient but who were not related.

<sup>c</sup> Community carriers = those discovered on investigation of a case but who did not live in the same premises as the patient.

<sup>d</sup> Restaurant carriers = those found following the investigation of a restaurant.

<sup>e</sup> Nightsoil carriers = those traced by nightsoil sampling.

The number of carriers detected by the first or subsequent rectal swabs is shown in Table 4. In 1961 it is probable that several carriers were missed, as a definite routine for the detection of carriers had not been established. The years 1963 and 1964 demonstrate the importance of the third and subsequent swabs. It would appear from the table

TABLE 4  
CHOLERA CARRIERS BY POSITIVE SWAB NUMBER AND YEAR <sup>a</sup>

Swab no.	1961		1962		1963		1964		Total	
	No.	%	No.	%	No. <sup>b</sup>	%	No. <sup>b</sup>	%	No.	%
1	36	67.9	12	60	38	36.2	16	61.6	102	50.0
2	12	22.6	3	15	14	13.3	2	7.7	31	15.2
3	5	9.5	5	25	32	30.5	3	11.5	45	22.1
4	NT		—	—	12	11.4	2	7.7	14	6.9
5	NT		—	—	4	3.8	1	3.8	5	2.4
6	NT		NT		2	1.9	1	3.8	3	1.5
7	NT		NT		3	2.9	1	3.8	4	1.9
Total	53	100	20	100	105	100	26	100	204	100

<sup>a</sup> No carriers were detected in 1965 and 1966. NT = not taken.

<sup>b</sup> Excluding nightsoil carriers.

that at least 7 daily rectal swabs are required to be sure of detecting most of the carriers.

This section has detailed how 221 carriers were detected but it must be realized that those found represent only a very small percentage of the number of infections that occurred in the community at the time. Consideration should be given as to whether such intensive investigations for the detection of carriers should be continued or limited only to determining sources of infection.

#### TREATMENT OF CARRIERS

Oral streptomycin has been the drug of choice for the treatment of carriers in Hong Kong since 1961 and, with the exception of 18 carriers who were treated by chloramphenicol, all have received this drug.

The dosage schedule has been as follows:

- (1) for those over 10 years of age, 8 doses of 1.0 g at hourly intervals;
- (2) for children aged 2–9 years, 8 doses of 0.5 g at hourly intervals;
- (3) for children under 2 years of age, 8 doses of 0.25 g at hourly intervals.

Oral streptomycin has several advantages over other antibiotics in the treatment of carriers. These

are its cheapness, the fact that treatment can be completed in 1 day, the absence of side-effects and, because of its very limited use by medical practitioners, the remote possibility of vibrio-resistance to it.

One disadvantage however, must be recognized, and this is that resistance can develop within 24 hours. Consequently post-treatment rectal swabs must be taken to determine the efficacy of treatment.

In 1961 sensitivity tests were not carried out either before or after treatment. In 1962–64 the sensitivities of all cholera organisms cultured from carriers were determined for tetracycline, streptomycin, chloramphenicol and furoxone. These were determined before treatment, and after treatment if the carrier state had persisted. The most important finding from these tests was that initial resistance to streptomycin was never found but resistance to tetracycline was found on 8 occasions in 1963.

Any carriers who continued to excrete vibrios resistant to streptomycin after treatment were given a 5-day course of chloramphenicol (250 mg at 6-hourly intervals). No long-term follow-up of treated or untreated carriers in Hong Kong has been undertaken as the general policy has been that once the carrier state has been determined, treatment must be given.

The treatment regimes given to 221 carriers are shown in Table 5. Of those initially treated with oral

TABLE 5  
TREATMENT OF CARRIERS <sup>a</sup>

Treatment	Result	1961	1962	1963	1964	Total
Chloramphenicol	Found cleared by 3 negative rectal swabs	18	—	—	—	18
Streptomycin	Found cleared by 3 negative rectal swabs	31	—	—	—	31
	Found cleared by 5 negative rectal swabs	—	20	108 <sup>b</sup>	27	155
Streptomycin	Failed to respond subsequently treated with chloramphenicol	4	—	11 <sup>c</sup>	2	17
Total		53	20	119	29	221

<sup>a</sup> No carriers were treated in 1965 and 1966.

<sup>b</sup> Includes 7 carriers resistant to tetracycline on sensitivity test.

<sup>c</sup> Includes 1 carrier resistant to tetracycline on sensitivity test.

streptomycin, 91% responded to treatment and the remaining 9% responded to a single course of chloramphenicol. Since 1962, the criterion for determining response to treatment has been the demonstration of 5 consecutive daily negative rectal swabs.

#### DISCUSSION

In the years under review, cholera cases in Hong Kong have been sporadic with some clustering of cases if a common source of infection was involved. This pattern suggested that the main means of spread was by direct contact with a case or carrier or by the consumption of food contaminated by a case or carrier. Very intensive case investigation was undertaken with the isolation of contacts in a quarantine centre; since 1962 positive nightsoil samples have also been investigated. These 3 operations are expensive in money, staff and equipment and the desirability of carrying out all of these procedures should be considered.

Case investigation should be undertaken with the sole object of determining the source of infection. For this to be effective notification of the disease must be received by the investigator as soon as possible, as any delay lessens the chance of tracing the source. Case investigation must be thorough and the information must be compiled in such a way that specific details in multiple case-histories can be compared at a glance. Despite careful investigation in Hong Kong during the period 1961-66, however, only on 6 occasions has the source of infection been

determined; 2 of these sources were important, however, and could have become foci of major outbreaks.

Isolation of contacts of cholera cases is an expensive procedure in terms of the staff, equipment and buildings which must be made available, and the benefits of isolation are of little importance when compared with the disruption of family life and loss of employment, which is very commonly associated with this form of quarantining. Between 1961 and 1966 only 221 carriers were detected among contacts of cholera cases, and this figure probably represented only a very small percentage of the total number of infections which occurred in the community during this time, as evidenced by results of nightsoil sampling (Van de Linde & Forbes, 1965). Isolation of contacts when major sources of infection, such as restaurants, are involved could be justified but the isolation of domestic and family contacts must be considered of doubtful value and could be replaced by chemoprophylaxis with oral streptomycin.

Nightsoil sampling is a good indicator of the presence or absence of the cholera vibrio in the community but the back-tracing of positive samples is time-consuming and requires skilled staff who could be better employed in case investigation. Nightsoil sampling and isolation of contacts can produce hundreds of samples daily which can disrupt the essential routines of most laboratories.

In the past large sums of money have been expended on virtually useless cholera control measures

which have borne no relation to the known means of spread of the disease and it is important that each health authority should use those measures best suited to its own region. In the future it is to be

hoped that basic principles of cholera control can be evolved which relate to the various geographical and environmental conditions under which the disease is likely to occur.

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### RÉSUMÉ

Les auteurs décrivent de façon relativement détaillée les méthodes utilisées à Hong Kong pour étudier les cas de choléra et dépister les porteurs de germes parmi les contacts; ils indiquent également les grandes lignes du traitement auquel ont été soumis les 221 porteurs découverts entre 1961 et 1964. Un tableau montre les nombres de cas de choléra, de contacts, de porteurs et de décès enregistrés à Hong Kong entre 1961 et 1966.

Pour être valable, l'étude des cas de choléra exige avant tout que l'on dispose de personnel qualifié et d'un matériel suffisant. La formation du personnel est relativement simple et l'équipe, qui doit être dirigée par un médecin, comprendra un inspecteur d'hygiène, deux inspecteurs sanitaires, un vaccinateur et le chauffeur d'un véhicule du type camionnette. Le matériel transporté devra inclure tout ce qu'il faut pour effectuer un examen bactériologique complet de l'habitation des malades, de leurs contacts, de leur lieu de travail et de l'endroit où ils prennent leurs repas.

Le but essentiel d'une étude sur le choléra est de remonter à la source de l'infection, mais elle comporte également des objectifs secondaires: a) dépister et isoler les contacts qui vivent au domicile du malade; b) déterminer l'étendue de la contamination à l'endroit où un malade a vécu, travaillé ou mangé; c) dépister les porteurs de germes parmi les contacts et d) identifier tous les autres contacts et les isoler si nécessaire.

A Hong Kong, le dépistage des porteurs s'est toujours fait par écouvillonnage rectal. En 1961, on considérait comme suffisant d'effectuer de 1 à 3 écouvillonnages pour le diagnostic et 3 écouvillonnages de contrôle après le traitement. Mais les lacunes de ce système sont bientôt

devenues évidentes et, en 1962, le nombre des écouvillonnages pratiqués pour le diagnostic et après le traitement a été porté à 5 à un jour d'intervalle puis, en 1963, le nombre des écouvillonnages pratiqués pour le diagnostic a été augmenté à 7. On estime maintenant qu'il faut effectuer au moins un écouvillonnage rectal quotidien pendant 7 jours pour dépister tous les porteurs et au moins un écouvillonnage rectal quotidien pendant 5 jours après le traitement pour savoir si le malade est guéri.

Depuis 1961, à Hong Kong, on donne la préférence à la streptomycine par voie orale pour le traitement des porteurs et, à l'exception de 18 sujets qui ont reçu du chloramphénicol, tous les porteurs ont été traités de cette manière. La posologie était la suivante: pour les sujets âgés de 10 ans et plus: 8 doses de 1 g à 1 heure d'intervalle; pour les sujets âgés de 2 à 9 ans: 8 doses de 0,5 g à 1 heure d'intervalle; pour les sujets âgés de moins de 2 ans: 8 doses de 0,25 g à 1 heure d'intervalle.

La streptomycine par voie orale présente de multiples avantages: faible prix, absence d'effets secondaires, possibilité d'administrer le traitement en un seul jour et, étant donné l'usage restreint qu'en font les médecins, réduction au minimum des risques de voir apparaître une résistance des vibriens. La résistance à la streptomycine peut cependant se développer dans les 24 heures; aussi faut-il pratiquer des écouvillonnages rectaux pour vérifier l'efficacité du traitement.

Sur l'ensemble des porteurs initialement traités par la streptomycine par voie orale, 91% ont réagi à la thérapeutique et les 9% restants ont été guéris par un seul traitement par le chloramphénicol.

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