

Cholera in Indian cantonments and how to deal with it : written for the use of Cantonment magistrates, medical officers and others interested in the question / by E.H. Hankin.

Contributors

Hankin, E. Hanbury 1865-1939.

Publication/Creation

Allahabad : Pioneer Press, 1895.

Persistent URL

<https://wellcomecollection.org/works/fgfv9nh2>

License and attribution

This work has been identified as being free of known restrictions under copyright law, including all related and neighbouring rights and is being made available under the Creative Commons, Public Domain Mark.

You can copy, modify, distribute and perform the work, even for commercial purposes, without asking permission.



Wellcome Collection
183 Euston Road
London NW1 2BE UK
T +44 (0)20 7611 8722
E library@wellcomecollection.org
<https://wellcomecollection.org>

Cholera in
Indian Cantonments.


TRO
Crawf.
Coll.
/HAN

Craig Collection

1901-10-10

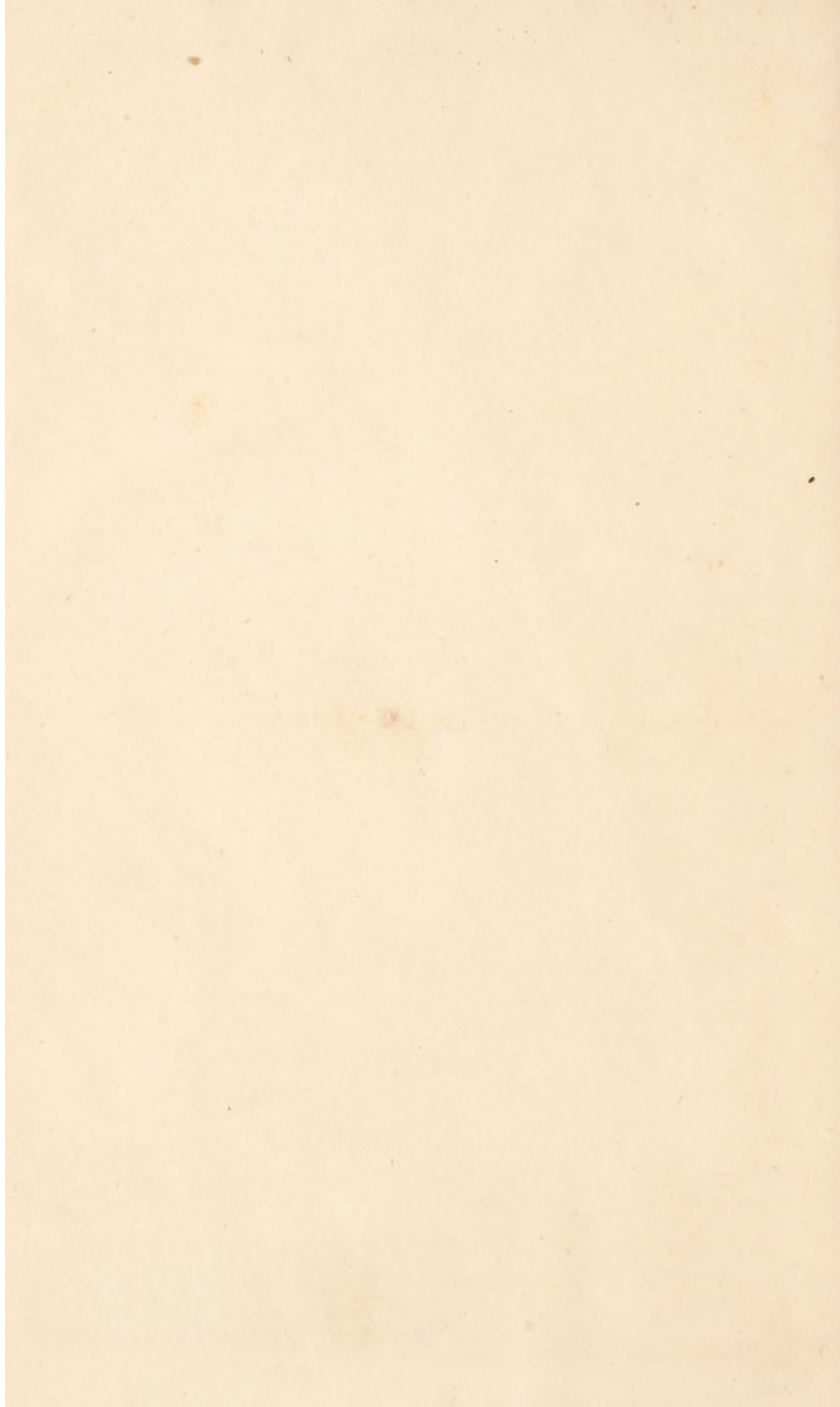


22101480214



Digitized by the Internet Archive
in 2017 with funding from
Wellcome Library

<https://archive.org/details/b28987688>



D. S. Crawford
27th March 1896

CHOLERA

IN INDIAN CANTONMENTS

AND

How to deal with it.

WRITTEN FOR THE USE OF

CANTONMENT MAGISTRATES, MEDICAL OFFICERS AND OTHERS
INTERESTED IN THE QUESTION.

BY

E. H. HANKIN, M.A.

Fellow of St. John's College, Cambridge, Chemical
Examiner and Bacteriologist to the N.-W.
Provinces and Oudh, Agra, India.

ALLAHABAD

PRINTED AT THE PIONEER PRESS

1895



323840

Crawford Collection

WELLCOME INSTITUTE LIBRARY	
Coll.	welTROmec
Call No.	Crawf.
	COU
	/HAN

PREFACE.

I BELIEVE that this is the first time that an attempt has been made to apply the knowledge of the cholera microbe that has been obtained during the last three years in forming directions for dealing with epidemics of cholera as they occur in Indian Cantonments.

I am fully aware that my experience is not sufficient to qualify me for the task, but still I have ventured to spend a few days' casual leave in writing this book, hoping to be able to take advantage of the criticisms that I expect it to incur.

This book must not be regarded as an attempt to make a definite or official code of rules. It merely contains my own opinions on the subject of the best way of preventing the spread of cholera, and in certain minor details these will be found to differ, both from the existing rules in use among British troops, and also from the rules published by the German Government for use in combating the epidemic that threatened that country in 1893. I have added in an Appendix a translation of portions of this code.

So far as the differences between my own suggestions and the rules published by the German Government are concerned, a comparison will show that they are in great part due to the differences in the conditions of the localities to which they are intended to be applied. It is obvious to any one who knows India that the thorough but expensive mode of disinfection recommended by the Germans would often not be applicable, especially when dealing with natives, and my experience of the cholera microbe in India leads me to suspect, that the rough and ready methods that I have put forward will be found to be sufficient for the purpose. After all, what is required is not necessarily to kill the cholera germ, but to render it harmless. In many parts of India, the latter alternative will often be the only one that is attainable.

It will be found that in the German code of rules great stress is laid on disinfection of the dejecta. The risk of infection from the dejecta is regarded as the root of the evil, and the most frequent source of infection. I believe that practically always a cholera outbreak among British troops in Cantonments is ultimately due to an importation of the microbe by natives, who in many cases are not suffering from the

disease at the time ; and that medical officers are not likely to have an opportunity of dealing with the microbe until it is already in a position to infect the soldiers. Hence in this book I have laid more stress on disinfecting the water supply, on washing the cooks and cook-houses with antiseptic solutions, and on supervising arrivals from other places, than on disinfecting the dejecta, or on other ways of preventing the patient from becoming a source of infection. Under existing conditions the chance of European patients infecting the water supply is trivial, since Europeans do not as a rule draw water for themselves, and since the only natives who will touch or remove dejecta (the sweeper caste) are not allowed by other natives to go near a well, or even in some places to get water from a standpost.

With regard to the paragraphs dealing with improvements that are advisable in cook-houses, I should like to point out that I have merely made suggestions that I believe to be practically obtainable during a cholera epidemic. More permanent improvements that are generally admitted to be desirable, I have not ventured to discuss. Nearly all the suggestions that I have made in this tract I know to be practical, as I

have carried them out myself with some other measures in the kitchen of the Agra Club, with the co-operation of Lieut. Smallwood, the Hony. Secretary.

I owe my best thanks to Surgeon-Major Lukis, I.M.S., Civil Surgeon of Fyzabad, and Surgeon-Major Peyton, S.M.O., Cawnpore, for having kindly read the greater portion of the manuscript, and for having given me the benefit of their advice and experience.

TABLE OF CONTENTS.

CHAPTER I.

INTRODUCTORY—THE NATURE OF CHOLERA.

	PAGE.
Theories that have been held as to its nature ..	1
Miasm <i>versus</i> Microbe	2
Difficulties in the way of accepting the latter as the cause of cholera in India	3
Sporadic cases	5
Degchie and food poisoning	<i>ib.</i>

CHAPTER II.

THE CHOLERA MICROBE.

(1)—Its mode of life outside the human body ..	7
(2)—It cannot be removed by ordinary filtration ..	11
(3)—It is easily destroyed by boiling	13
(4)—It is easily destroyed by drying	<i>ib.</i>
(5)—It is easily destroyed by acids	14
(6)—It varies in virulence, a fact that may explain some cases of irregular distribution	15
(7)—Its growth is stated to be favoured by traces of salt and nitrates	<i>ib.</i>

CHAPTER III.

EXAMPLES OF EPIDEMICS IRREGULAR AND OTHERWISE.

(1)—Example of water infection chiefly affecting Brah- mins	17
(2)—Example of water infection chiefly affecting Mus- almans	20
(3)—Example of water infection only affecting certain companies in a British Regiment	23

(4)—Example of infection through food among British troops	PAGE.	30
(5)—Example of infection produced by means of flies ..		31
(6)—Example of infection carried on clothing ..		32
(7)—Example of infection carried in milk ..		<i>ib.</i>
(8)—Example of infection carried on fruit ..		34

CHAPTER IV.

PRACTICAL PRECAUTIONS AGAINST THE SPREAD OF CHOLERA IN CANTONMENTS.

I.—Precautions to be taken when Cholera is about.

- (1)—Persons returning from infected districts not to be allowed to approach a well. Examples of importation 36
- (2)—Cook-houses and cook's mates to be cleaned and disinfected 41
- (3)—Dish-cloths to be disinfected 45
- (4)—The floor of the cook-house to be disinfected with chloride of lime or permanganate of potassium .. 46
- (5)—The water supply.—If pipe water, not likely to become infected 47
 - If open wells, liable to become infected at any moment .. *ib.*
 - If closed in wells, liable to become infected once a week when a man goes in to oil the pump, and when the attached filter tanks are cleaned out .. 48
- Forbid ablutions near the drinking water wells and allow no one except *bhistis* and water drawers to approach the well as far as possible *ib.*
- Stagnant wells to be treated with a quantity of permanganate of potassium 49

II.—Precautions to be taken on the appearance of the first case.

- (1)—Have the dejecta bacteriologically examined .. 50
- (2)—Have the water supply examined in the same way.. 51
- (3)—Arrange to disinfect dejecta, preferably with carbolic acid or chloride of lime *ib.*

	PAGE.
(4)—Disinfection of hands of persons who come into contact with the patient	52
(5)—The disinfection of wells	<i>ib.</i>
(6)—Soldiers should be warned against the danger of drinking water. Their facilities for getting aerated waters should be increased. Provide boiled water, but do not filter it. Illustration of its use in the Neitleben Lunatic Asylum. Empty soda water bottles from a cholera hospital	53
(7)—Precautions to be taken on the spot if the case is in a native house in cantonments. The native's views on sanitation, and on the concealment of cholera cases.. .. .	56
(a) The patient better not in hospital if this involves compulsion	60
(b) The dejecta to be rendered harmless by disinfection or by drying the floor with burning charcoal. Illustration of the risk involved in digging up the mud floor	<i>ib.</i>
(c) Food found in the house to be burnt, unless dry grain, &c.	62
(d) Water found in the house except holy water to be thrown away	<i>ib.</i>
(e) Cooking vessels to be dried by hot ashes, but not touched by a European	64
(f) The place where the cooking vessels are washed up to be disinfected. Also neighbouring drains	65
(g) Clothes and linen of the patient not to be burnt but boiled	<i>ib.</i>
(h) Funeral customs of natives not to be interfered with, except corpses should not be thrown into a river. Antiseptics not to be thrown into the grave	66
(i) The relatives of the patient not to be turned out of the house, unless they are engaged in occupations involving contact with other people's food	71
(8)—Precautions to be taken on the spot if the case occurs in a European house or barrack	72
Partly as above, but also :—	
(a) The sweeper to be taught to use disinfectants for himself and utensils	73

	PAGE.
(b) Only freshly boiled water to be drunk in the house	73
(c) Sulphuric acid to be added to water in which plates and dishes are washed	74
(d) Dish-cloths to be dried every day in the hot case	<i>ib.</i>
(e) Floor and furniture to be disinfected with sublimate solution or carbolic acid	<i>ib.</i>
(f) Fumigation useless and dangerous	<i>ib.</i>
(g) The possible utility of fly-papers	75
(h) The house or barrack not to be evacuated, except so far as is necessary for disinfecting it ..	76
(9)—Other precautions	77
(a) The consumption of uncooked fruit, &c., to be stopped	<i>ib.</i>
(b) Predisposing influences to be avoided ..	78
(c) Fear of the disease	<i>ib.</i>
(d) Milk	<i>ib.</i>
(e) Adulteration of beer	79
(f) Butter	<i>ib.</i>
(g) Ice factory	<i>ib.</i>
(h) Bread	<i>ib.</i>
(i) Personal contact	80
(j) Mussacks	<i>ib.</i>
(10)—Cholera Camps have done good in the past, because they removed troops from the infected food and water. Their probable necessity in the future.	81

APPENDIX I.

The disinfection of wells—

(1) With permanganate of potassium	84
(2) With lime	<i>ib.</i>
(3) With alum	85

APPENDIX II.

Extracts from the German Cholera Regulations ..	87
---	----

CHOLERA

IN INDIAN CANTONMENTS

And how to deal with it.

CHAPTER I.

INTRODUCTORY.

THE NATURE OF CHOLERA.

TWO views have long been held as to the nature of cholera. One is, that it is due to a miasm bred in the soil, from which it was supposed to pass into the air and thence find its way into the human system where it produced the disease. This view was based on no experimental data. It made no profession of any ability to explain what was a miasm, or what was meant by its "breeding." It is a view lineally descended from the old idea that an epidemic was caused by an effluvium from a comet's tail, and it is a view that has never acquired the definiteness of a scientific conception.

The conception the nature of cholera that is now universally accepted in the scientific world

is, that in accordance with the analogy of other diseases, it is caused by the microbe that is always associated with it. The cholera microbe commonly known as the "comma bacillus" from its resemblance in shape to the comma as printed in the old German type, was discovered by Koch in 1884. It was greeted with a lively storm of opposition on its first introduction to the scientific world. Lewis found it in his mouth when he was working with it in his laboratory, and as he was not then suffering from cholera, his observation was regarded as a proof of the harmlessness of the microbe. Koch himself failed to produce cholera or anything resembling that disease by means of this microbe in animals. Klein and other observers swallowed it without experiencing any ill effects, and other microbes, certainly harmless, but practically indistinguishable from it, were found in old cheese and other substances.

Since then however Gamaleia, Haffkine and Metschnikoff have succeeded in producing fairly typical cholera in dogs and rabbits by means of this microbe. Metschnikoff, myself and other observers, have produced experimental cholera in man by its means. One or two cases of fatal laboratory infection are also known, and furnish further proofs of the causal relation of the cholera microbe to the disease. We are beginning to comprehend the fact that the cholera microbe is the most variable of microbes, not only in its form and physiological characters, but also in its virulence,

and in this direction is to be found an explanation of many cases in which "comma bacilli" have been found to be innocent of disease-producing powers.

It must be admitted that there are certain difficulties in the way of accepting the cholera microbe as the cause of the disease in India. Some have thought that in India it must travel in ways unknown to European observers. But I am convinced that these difficulties are for the most part based on the imperfections of our knowledge of the biology of the microbe in question. Just as any one may admit that mosquito bites are caused by mosquitoes, but may be unable to explain why mosquitoes are more prevalent at particular times and places than at others, so it seems to me to be a logical position to hold, that cholera is caused by the cholera bacillus, though we may not as yet know enough about its biology to explain why it should be more prevalent in one year or in one place than in another. An example of a difficulty in the way of accepting the cholera microbe as the cause of the disease that is based on ignorance of its properties, is the fact that cholera in the valley of the Ganges never travels down stream. Frequently cholera corpses are thrown into the Ganges, Jumna and other rivers. The cholera microbe therefore constantly gets into the water of these rivers and is carried down stream. Why then do not the natives get cholera by drinking such water, though they do so apparently by drinking river

water in other parts of India? The explanation is extremely simple. My observations⁽¹⁾ concerning the paucity of microbes in these Indian rivers led me to make the suggestion that the cholera microbe probably dies when placed in the water of such rivers. Since then I have tested this supposition in my laboratory, and found that for the Jumna water at Agra it is a positive fact;⁽²⁾ and that this water acts as a feeble antiseptic to the cholera microbe, while the same microbe reproduces rapidly in well water under otherwise similar conditions.

Another objection that has been raised to the idea that cholera is caused by a microbe, is the asserted fact that cholera often shows extreme capriciousness in its distribution in any locality. In fact, from the way some people talk of it, one would think that it always made geometrical patterns in choosing its victims. I have formed the impression, that persons who on such grounds assert that cholera is inexplicable, too often regard their opinion as an excuse for not attempting to find an explanation of the facts that they consider so mysterious, and thus they are badly qualified for making authoritative statements of this nature. Examples of curious cases of distribution will be

(1) Hankin : "The Microbes of Indian rivers." (Transactions of the First Indian Medical Congress, December, 1894, p. 241.)

(2) Hankin and Gadially : "A further analysis of the water of the Zem Zem well in Mecca," (*British Medical Journal*, July 27th, 1895, p. 193.)

given below, with the explanations that a little research has brought to light. I expect that it will be found that cases of irregular distribution are always due either to peculiarities in the microbe, to ill-understood native customs, or to peculiarities in the water-supply of the infected area.

Whatever theory may be held as to the nature of cholera, sporadic cases must be difficult to explain. Probably in many cases the truth about them is that they are not in reality cholera at all, that is to say, they are not caused by the cholera microbe. For instance, at the beginning of the summer this year two cases of "sporadic cholera" occurred in Agra. In neither case did the bacteriological test reveal the presence of cholera microbes in the dejecta, and in one case there was a history of eating bad food a couple of days before the attack.* Water used by two patients suffering from "sporadic

* I believe that Cunningham has quoted his failure to detect the cholera microbe in the dejecta of certain cases of undoubted cholera as an argument against the idea that cholera is caused by the cholera microbe. This work, as is the case with most of Cunningham's work on the subject, is weakened by the fact that he worked without the advantage of the peptone method. It is only by means of this recently discovered method that it has become possible to detect the cholera microbe with certainty in substances in which it is only present in traces. In one of his most recent papers Cunningham has stated that he thinks it likely that Haffkine's inoculations with the cholera microbe will decrease the mortality from cholera. Whatever may be thought of this statement, it appears to me to indicate that his attitude towards the cholera microbe is not so completely sceptical as was once the case.

cholera" in other parts of India was sent to me about this time. In neither case was the cholera microbe detected.

Probably such cases are often due to food-poisoning. It is now known that if food is kept for some time, microbes that may be present may in some cases produce poisonous substances in the course of their growth. Swallowing these substances is known in some cases to give rise to choleraic symptoms.

Isolated cases of cholera may also conceivably be produced by accidental infection from a well that is not much used. For instance, once near Futteypore Sikri, and once in Daragunj, I have found the cholera microbe in a state of full virulence in the absence of cholera. In each case it was in a well whose water was not used for drinking purposes. It is at least conceivable that a stranger travelling through the places mentioned, and not knowing that the water was stagnant, might take a drink from these wells. In this way an isolated case of cholera might be produced, or even an epidemic might be started in which there might be no evidence of importation.

CHAPTER II.

THE CHOLERA MICROBE.

ALTHOUGH this book is intended to present little more than practical hints on the prevention of cholera, it will be necessary to commence with a short account of certain properties of the cholera microbe, for, as will be seen, they are intimately bound up with precautions that may be taken against the spread of the disease.

(1) The cholera microbe when outside the human body, so far as is known, only lives and reproduces in water. Hence cholera in most cases is a water-borne disease. When growing in water its food is dissolved organic matter or, popularly speaking, dirt. But it can take this dirt from such extremely dilute solutions, that there is little doubt that ordinary chemical analysis is unable to tell whether the microbe will be more or less at home in any particular well.

The natural cessation of an epidemic of cholera does not depend on the microbe vanishing from the well water. After the cessation of the epidemic, it is commonly still to be found in the well water for an interval of one to three months. During this time it is found to exhibit certain signs of

degeneration, which it does not show while the water is still infectious. After this time in most places the microbe completely vanishes.⁽³⁾ In localities on the other hand in which the disease is endemic or nearly so, the microbe may continue to exist for a longer time in the water. In Rampur, for example, out of 23 wells examined, I found the microbe still present in specimens from 12 wells nearly a year after cholera had been present in the locality. Rampur is a place in which it often happens that cholera breaks out anew with such suddenness and so widespread over the district, that there is no possibility of explaining the outbreak by importation or personal transport from place to place. The above described observation suggests that the microbe has thus remained latent in the well water, awaiting some change in temperature or other widespread condition which would allow it to increase in quantity or virulence sufficiently for it to be able to produce the disease. I am not aware of any reason for thinking that such a process ever occurs in any cantonments with which I am acquainted. On the other hand, the microbe would seem to be imported anew for each epidemic in a virulent condition. A corollary from these results is, that even after the cessation of an epidemic, the bacteriological test may be able to tell

(3) See "The Annual Report of the Chemical Examiner and Bacteriologist to the North-Western Provinces and Oudh for 1894" (published at the Government Press, Allahabad, India,). Price, One Rupee.

which wells have been responsible for the outbreak. The test is in such a case not too certain, both because degenerated cholera microbes are sometimes, but not often, carried from one well to another, and because these degenerated microbes are somewhat difficult to test for and recognize. Hence in all cases advantage should be taken of bacteriological tests in investigating an outbreak, either while it is going on or as soon as possible after its cessation.

The fact that water contains the cholera microbe is no reason for thinking that drinking it must necessarily be able to produce cholera even in a small percentage of the population. For it to be able to produce infection other conditions are necessary. It is not possible to be certain what these conditions are, but it is very probable that the chief determining conditions are those influencing the quantity and the virulence of the microbe. If the microbe is not fully virulent, it is likely that infection can only be produced if the microbe is present in comparatively large quantities. If it is fully virulent it is, *à priori*, likely that far smaller doses will be capable of producing infection. It is possible that among conditions influencing the quantity are the temperature, and the amount and nature of the available food materials. An analysis of the evidence at my disposal shows that the cessation of the cholera epidemic that has always followed the disinfection of wells in villages, is in many cases

causally related to this disinfection. It is extremely probable that these disinfectants have acted not so much in completely destroying the microbe, for I have evidence in some cases that it has not done so, but rather in removing some condition necessary for maintaining its virulence or its quantity. During the twelve months during which the methods of disinfecting well water have been tried, cholera, so far as I can learn, has been of a mild type all over India. It is possible that the disinfection of wells will not be found so efficacious in future years when we may have to deal with a more virulent variety of the microbe, which may be infectious in smaller doses. How far this line of argument is correct, can only be shown by future experience. Considering the amount of evidence that is now accumulated, that cholera is caused by swallowing a microbe in water in the great majority of cases, and considering the fact that it is known that the microbe in question is one of the most easily killed by antiseptics, it is scarcely probable that the disinfection of wells will not be found to be efficacious. The question that remains at issue is whether disinfection, by the methods I have recommended, will be found to be sufficiently powerful to produce the effect required, in all cases.

As I have elsewhere explained,⁽⁴⁾ the disinfection of wells with permanganate of potassium

(4) Hankin : " The disinfection of wells as a means of combating cholera epidemics " (Transactions of the First Indian Medical Congress, p. 300, December, 1894) also, " The disinfection of wells " (*Indian Medical Gazette*, November, 1894).

seems merely to hasten a process that would occur of itself more slowly if permanganate was not employed. Hence, unless accurate details of the course of permanganated epidemics can be obtained and compared with details of other epidemics under similar conditions of time and locality in which the water-supply was not disinfected, great difficulty will be met with in arriving at a conclusion on this point.

(2) The cholera microbe is small, so small that 60 placed in a row, end to end, make a line whose length is only equal to the thickness of a hair. Hence it is impossible to remove them by filtration through ordinary domestic filters, and these should be thoroughly distrusted in a cholera epidemic.⁽⁵⁾

The system of sand filtration on the other hand that is used in Municipal Water Works is sufficient to remove microbes from water, and may be relied on as a rule.⁽⁶⁾ In this case the filtering medium is not really the sand, but a slimy layer consisting of fungi and microbes that forms on the surface of the sand. So long as it is intact this slime layer has the power of removing microbes from the water. In Lucknow in the summer of 1894

(5) Sims Woodhead and Cartwright Wood : " An examination of the different forms of domestic filters." (*British Medical Journal*, December, 1894.)

(6) Koch : " Wasser filtration and cholera." (*Zeitschrift for Hygiene and Infections, Krankhieten*, Vol. XIV, 1893.)

many cholera corpses came floating down the river, and on more than one occasion had to be pushed away with poles from the intake of the water-works. Nevertheless there is no reason to think that the cholera microbe ever got into the Municipal water-supply. I looked for it there on several occasions without success, and no case of cholera can be ascribed to the consumption of this water.

It must, however, not be forgotten that in certain cases in Europe a cholera outbreak has followed, and apparently been caused by, a breakdown of the Municipal filter beds. Each of these cases were, however, caused by a freezing of the filter beds, an accident that is scarcely likely to happen in India.

The Pasteur-Chamberland and Berkefeldt filters depend on a totally different principle from any other domestic filters, and so long as they are in working order they remove practically all microbes from water. Unfortunately, however, they are not always in working order. This has been the case with three of these filters that I have examined. One gave irregular results, sometimes keeping back the cholera microbe, sometimes letting it through. I believe that this was due to the filter being old and worn out. The second filter unfortunately had the different screws interchangeable, and the soldiers who had put it together had so arranged it that, on working the pump, it gave a plentiful supply of unfiltered water. This filter had been in use in a regiment for some time in place

of the Macnamara filter, I believe with benefit to the health of the troops! The third filter of this kind that came into my possession, was a small domestic form containing only one "candle." It allowed cholera microbes to pass through with facility owing to a crack that was large enough to blow through, but would probably have strained off shrimps. However, improvements are being introduced into the mechanical construction of these filters, by which these chances of accident will be minimised, but I doubt whether it would be safe to rely on any "candle" whether of porcelain or infusorial earth, unless it has been subjected to a severe bacteriological test.

(3) The cholera microbe is easily and rapidly destroyed by boiling. I have heard of a case of a cholera epidemic among soldiers in which orders were issued to boil the water. It was considered necessary to wait for two days, before doing this, in order that the vessels in which it was to be done might be freshly tinned, and when at length the water was boiled it was considered necessary to heat it for two hours. This was waste of fuel, as two minutes boiling would have been ample for disinfecting water; and surely this idea of tinning degchies need not have been paraded while a virulent epidemic was going on, which, as later research proved, was due to drinking un-boiled water and nothing else.

(4) The cholera microbe is rapidly destroyed by drying. Therefore the disease is never, in the true

sense of the word, air-borne. For the same reason clothes may be disinfected by drying. To do this all that is necessary is to expose them for a day or more, according to their thickness, in the sunlight during the hot weather. I doubt whether this method can be relied on during the rains in the North-West Provinces, or at other times in places in which there is a good deal of moisture in the air. Dry food, such as parched grains, is less likely to convey the infection than damp cooked food. Hence, so far as possible native servants should only be allowed to bring dry food from the bazaar if cholera is there prevalent.

(5) The cholera microbe is readily killed by acids. Hence the advisability of using acid disinfectants, and the utility of acid drinks as a means of preventing infection. The use of dilute sulphuric acid as a prophylactic, and in the early stages of the disease, is probably partly due to its antiseptic action on the cholera microbe.

The carbonic acid in aerated waters exerts a strong antiseptic action on cholera microbes. I have recently found that if soda is added to aerated water the action of the gas in killing the microbe is somewhat less energetic. Hence this substance should not be used. Soldiers in this country drink large quantities of aerated waters. They are most fond of "champagne-cider," "gingerade," &c. Tartaric acid enters into the composition of all of these drinks, and no doubt aids the action of the gas on the microbe of cholera. I know no

reason why a small quantity, say 10 drops, of dilute sulphuric acid, should not be added to each bottle of lemonade before bottling during a cholera epidemic, and a daily ration of a bottle of this mixture given free to each man so long as the danger lasts. If this plan were introduced, it would be necessary to see that the syrup and acid mixture should be measured out in a glass or earthenware measure and not in a tin vessel, as is often the practice in soda water factories.

Probably the reason why so few cases of milk infection in cholera are known, is the fact that cholera microbes are killed by acids, and milk rapidly acquires an acid reaction on the onset of decomposition. This change, though harmful to the microbe of cholera, offers but slight hindrance to the growth of that of enteric. Hence milk is probably in many cases the cause of the latter disease.

(6) The cholera microbe varies in virulence. This fact will probably account for some peculiarities in its way of spread. In the year 1894 I detected the cholera microbe in the wells of five hospitals in cantonments, but only in four cases was there any cholera among the inmates. In two cases the disease was confined to patients who had previously been suffering from enteric or simple continued fever, conditions that are known to predispose to cholera. In such cases it is probable that the microbe possessed but a slight degree of virulence and hence the infection produced was

limited, although large numbers of persons drank the water of the wells in question.

(7) Laboratory experiments have shown that the cholera microbe is favoured in its growth by the presence of traces of common salt and of nitrates in its culture fluids. Similarly, in the coast districts in Bengal where cholera is endemic, an outbreak of this disease frequently follows the coming of a tidal wave, one of whose effects is to flood the tanks of drinking water with saline matter. Other causes may be here operative, but this fact indicates the advisability of regarding with more suspicion a well whose water contains an unusually large amount of chlorides or of nitrates ; but it appears to me that it would be wiser during a cholera epidemic to regard water from any well as a good culture medium for microbes and as a bad beverage for human beings.

CHAPTER III.

EXAMPLES OF CHOLERA EPIDEMICS
IRREGULAR AND OTHERWISE.

THE following examples of the irregular distribution of cholera cases may be of interest and use, both in giving hints towards the elucidation of cholera outbreaks in the future and in explaining why our predecessors, working as they did without precise bacteriological knowledge, had the conclusion forced upon them that cholera was an inexplicable disease.

(1) *Example of an epidemic affecting chiefly Brahmins.* I am indebted to Surgeon-Captain Drake Brockman for the following very interesting case:—

Cholera was introduced into a village in the Muttra district in the person of a Chamar child. One other Chamar was affected, but otherwise the disease left the Chamar portion of the village and appeared among the Brahmins. For some time the disease was confined to that caste, which it attacked with extreme virulence. Afterwards, however, as the outbreak was dying out and becoming less severe, scattered cases occurred among other castes resident in the village. At first sight this outbreak appears to present a disproof of the idea that cholera is a water-borne disease. The Chamars live together in a separate portion of the village with a separate well

for their water-supply. The Chamars being of low caste it is not likely that members of other castes would ever go there to get water, still less likely that Brahmins would do so. Further, since the disease was introduced by a Chamar child, one would have expected that the Chamar water supply would have become infected and that the disease would have remained in this portion of the village. On the contrary, the outbreak appeared among the Brahmins. The suggestion that possibly the well used by the Brahmins had become infected was inadmissible, as this well was also used by other high castes, such as Chutris and Bunneas, who remained for the time unaffected by the epidemic. Brahmins have a habit of each family cooking their own food apart and eating it while fresh. There was then no likelihood that the Brahmin caste had some particular food that was not used by members of other castes. Further, there was no evidence that a caste feast for Brahmins only had recently been held. Such an explanation would scarcely explain the continued succession of cases. No theory of personal contagion would fit the facts, for the Brahmins did not live together in one part of the village, and must have come into contact with all, except those of lowest castes, during their daily occupations. There is no likelihood that the infection was carried by a drain or by underground currents from the Chamars' quarters to the drinking water of the Brahmins, as, among other reasons, the well used by the Brahmins was situated at the opposite side of the village

to the Chamar quarters. In fact, I suppose the upholders of the view that cholera is due to a miasm nourished on oscillations in the level of the ground water, would have found that the facts fitted their view as well as any, and at any rate that they excluded the theoretical conceptions of others. Nevertheless a further more minute examination of the facts of the epidemic furnished a proof that it was due to water infection. Surgeon-Captain Drake Brockman enquired who had cleaned up the dejecta of the child. An old woman (the child's grandmother) came forward and explained that she had mixed the dejecta with earth and thrown them away. On being asked where she had washed her hands after doing this, she led the way to a pond situated outside the village and on the same side as the residences of the Chamars. It was found that this pond was used by the women of the village in washing up their household utensils. The Brahmin women used a place separate from other castes at one end of the pond. Most other castes used to wash up at the opposite extremity of the pond. The Chamars had a place reserved for them at one side of the pond, and nearest to the place used by the Brahmins. On the opposite side the cattle used to come to drink. Thus it is evident that the Chamar old woman had introduced the infection into the pond near where the Brahmin women were in the habit of washing their cooking vessels. It is then probable that by this means the infection was carried on to their food. It may be noted that the Chamars, at any rate if they

are poor, use not brass but earthen vessels for cooking purposes. Earthen vessels are not cleaned by scrubbing with mud and water, as is the case with brass pots. Hence so far as the Chamars were poor, it is probable that their cooking vessels were washed up either in their houses or near their well. The poorest Brahmins on the other hand will only eat food from brass vessels. Of course each Chamar owns a brass lota for drinking purposes, but this would probably be cleaned with earth wherever he happened to use it. Thus it is likely that the Chamars were on the whole less exposed to the risk of infection of their cooking vessels than the Brahmins. The Brahmins appear to have been at first especially liable to such risk. Later on, when the infectious matter was more diluted, and spread over the tank, the members of other castes were equally exposed to the danger. Probably if it was not for this caste custom, and if the women of all castes had washed their vessels in one place promiscuously, the disease would have affected a far larger proportion of the population, as other castes would have been exposed to the infection while it was still fully virulent.

(2) *Example of an epidemic affecting chiefly Musalmans.*—Some time ago I investigated a small epidemic in Shahgunj, a suburb of Agra, which well illustrates the way in which untrue reports about cholera gain credence. At the time it was commonly reported in Agra that in this case the disease had only affected women, and without further enquiries this allegation was accepted by certain of my acquaintances as a fur-

ther proof of the inexplicability of cholera. The first fact that I found out about this outbreak was, that in reality it had attacked 16 males and 11 females. These figures did not completely dispose of my critics, as at the commencement of the outbreak a group of seven women and two children had been attacked, nearly all of which cases were fatal, while during the latter part of the epidemic there was no such preponderance of female cases, and the mortality was trivial. On investigation, I found out that these women, though living in one part of the village, obtained their water-supply from widely different sources. There was no reason for thinking that they had anything in common in their food-supply, and whatever they eat was probably shared by their husbands. Thus far the investigation went to show that the disease was a capricious and inexplicable disease of locality. Further research showed that it was not a disease of locality, but of the water in the locality. At least six out of the seven women were in the habit of going to one particular well to wash their household vessels, and probably at this time, as is customary, washed out their mouths with the water. The water of this well was regarded as brackish by the inhabitants, and was only drunk by a few poor Mahommedans. Hence it is not surprising that the disease affected 26 Mahommedans and only one Hindoo. During the later part of the epidemic the cholera microbe appears to have spread to every well in the place, and the disease began to become more widely spread and to attack both men and women. Why the microbe

showed more virulence when in the water of the above mentioned well, than in that of the others is not very clear. But it is a fact that the microbe existed in this well under different conditions to what it did in other neighbouring wells. For, potassium permanganate was added to these wells. It failed to remove the microbe (except temporarily) from the above mentioned infectious well, while it succeeded in removing it from the other wells. No further cases occurred after this treatment of the wells. The infectious well was badly situated in a dirty lane and closely surrounded with houses. The other wells were all situated in open places and apparently less exposed to human contamination. The practical lesson to be drawn from this outbreak is, that in dealing with a water-borne disease, it is not only necessary to supervise the water that is drunk, but also the water that is used for washing up or in cooking, or which in other indirect ways may come into contact with food or food utensils.

(3) *The cholera outbreak in the East Lancashire Regiment in Lucknow, that happened in July 1894*, aptly illustrates the difficulties that may attend the investigation of an outbreak of this disease, and the number of possible sources of infection discovered, both by the Medical Officers concerned, and by the Commission of Investigation, appear to me to make it a particularly instructive case for any officials who may have to deal with cholera in Indian cantonments.

The following account is mainly taken from my Annual Report as Chemical Examiner and Bacterio-

logist to the North-West Provinces and Oudh for 1894. For the evidence on which many of the following statements are based, I must refer the reader to the Report of the Commission of Investigation, which will, I hope, shortly be published :—

The outbreak in question presents several features of great interest. A few years ago it would without doubt have been quoted as a clear proof of the view that cholera is a disease of locality, or that it is caused by a miasma. Probably if I had not discovered the cholera microbe in the water supply, the outbreak would have been quoted as a conspicuous illustration of the incapacity of the "water-borne" theory of cholera to explain the facts connected with the distribution of the disease in India. Although all the companies of the regiment were living under exactly the same conditions of life, and their supplies of water and food were identical so far as could be seen, the disease showed the strangest preference for particular bodies of men, and certain barracks nearly or completely escaped the disease. Some companies furnished cases daily throughout the epidemic. Others had but single cases both while in barracks and while in the preparatory cholera camp, but on their arrival in the Kokrail Camp the disease broke out among them as severely as in the rest of the companies. The disease appeared suddenly in the Station Hospital, at the same time that the rest of the regiment was suffering so severely, although, so far as I know, there was nothing in common as regards water-supply or diet between the patients in hospital and

the men on duty in the regiment. The disease showed a preference for certain wards of the hospital, while others remained perfectly unaffected.

The epidemic was extremely severe while it lasted. Out of a total of 646 officers and men, there were 143 attacks, of which 92 terminated fatally.

The immunity of E. Company was at the time quoted as being perfectly inexplicable. The barracks inhabited by this company were almost surrounded by the barracks of companies who suffered severely from the disease. Yet why should the disease pass over the men of E. Company, whose conditions of life were identical with those of other companies, and appear among the hospital patients who were living in a totally different environment? On questioning the Colour-Sergeant of this Company, the mystery at first appeared to deepen, for he roundly asserted that the men under his charge had exactly the same supplies of food and water as the rest of the Regiment. But on his being pressed as to how he knew that the water-supply was the same, he replied that he ought to know, if anybody, as he boiled it himself! It is needless to say that on making enquiries we found that this sanitary precaution had not been taken by the other Colour-Sergeants.

At the time of the outbreak the immunity of other regiments in Lucknow was quoted as a proof of the mystery surrounding the march of cholera. The outbreak in the East Lancashire Regiment occurred at about the same time that the epidemic in the

neighbouring city reached its height. The two epidemics also died out at about the same time. Surely here was a proof that cholera was due to a miasma attached to the locality, and that the outbreak in the East Lancashire Regiment was due to a sort of overflow of the miasma from the city. But even on this view it is incomprehensible why one regiment was attacked, while other regiments, living on either side under apparently similar conditions, should almost completely escape the disease, with the exception of a few imported cases.

Investigation however showed that every one of these irregularities in the distribution of the disease furnished proofs that it had to do with the water supply and with nothing else. The drinking water supply of the different regiments was derived from closed in filter-tank wells. In the case of the East Lancashire Regiment the filter-tanks had been cleaned out and recharged in one case two, in the other case six days before the commencement of the outbreak. Most of the coolies employed in this work came from villages in which cholera was raging at the time. The cholera microbe was detected in the water coming from the filter-tank (*i.e.* after filtering) but not in the water coming direct from the well (*i.e.*, before filtering). Hence there is every reason for thinking that the coolies employed in cleaning the filters succeeded in infecting them with the cholera microbe. It is well to understand that no blame can fairly be laid on the Military Works Department, or on other officers, for this state of affairs. The coolies

themselves denied that any cholera had been in their villages during the summer, and it was not known that their villages had been infected with cholera till long afterwards, in spite of the strict rules that exist concerning the prompt reporting of cholera outbreaks. Further, it must be remembered that at the time the prevalent belief was, that the water-supply would necessarily be improved by renewing the filtering materials, and no one had any idea that these filters form excellent breeding places for the cholera microbe. The morals to be drawn from the incident are firstly, that it is not well to clean filters when cholera is about, and secondly, that one can never rely on coolies being free from infection if cholera is in the district. Thus we have a simple explanation of how the cholera infection was introduced into the East Lancashire regiment. We have equally satisfactory explanation of how it escaped the other regiments. The filter tanks of one regiment had not been cleaned out at all during this summer, and hence had not been exposed to any chance of infection. The filter tanks of another regiment were cleaned out a few days later, but by this time the newly introduced pipe water supply was at the disposal of the regiment, and the filter tanks were not used at all after cleaning. A third regiment had been in the habit of boiling all their drinking water during the whole of this summer. Lastly, the native regiments did not filter their water at all.

So far the investigation showed that the disease in the East Lancashire Regiment was due to an infection

of the water supply, and a satisfactory explanation was arrived at of the immunity of other regiments, but this was not a complete explanation of the course of the disease in the regiment in question. It was proved beyond any possibility of doubt that though their water supply had been taken from the infected filter tank wells while they were in cantonments, it was above suspicion while they were in cholera camp. While in the preparatory camp only municipal water was carried out to them in carts, and if the *bhistis* had disobeyed orders and taken water from any neighbouring open wells, it was free from the cholera microbe as shown by later examination. A degenerated cholera microbe was, it must be admitted, afterwards found in the well in the Kokrail Camp, and this well was no doubt used by the soldiers, but it is difficult to believe that it was the cause of any infection, as the native followers, who were more numerous than the soldiers, drank it freely, and so far as is known they remained perfectly exempt from the disease. The outbreak in the Station Hospital was found to have nothing to do with that in the regiment. The disease had been introduced by a *bhisti* who managed to infect the well used for drinking purposes in the hospital.

At the time of the appointment of the Commission of Investigation, I was fortunately engaged in examining the capacities of Macnamara Filters in respect of the cholera microbe. I had found that this form of filter is an excellent breeding place for these microbe. I found the cholera microbe in one of the

Macnamara Filters that had been employed throughout this outbreak, no less than six weeks after the filter had been last used. Of course by this time it had lost its infectious power, but the observation is of interest, as I am sure that no cholera microbe could survive so long in a culture tube in my laboratory, at that time of the year.

The suggestion is obvious, that the exacerbation of the disease that occurred after the men went into cholera camp, was due to their having carried with them the infected filters, and in this way water that was perfectly free from objectionable microbes became infected by its passage through the filters.

We found evidence that the filters used by "C" and "F" Companies were more strongly infected with the microbe of cholera than those used by the rest of the troops. This stronger infection appears to have got into these filters at the time that they were taken to pieces and put up again in the Preparatory Camp. Of the exact origin of this stronger infection we can give no definite explanation, either some organic matter that acted as food for the microbes got into this filter and not into the others, or the filters in question were infected by the men who handled them with a more virulent variety of the microbe than was present in the filter well. Hence so long as the soldiers were in the Preparatory Camp, "C" and "F" Companies yielded a succession of cases every day. The other Companies at this time furnished but few cases, as they were using less

strongly infected filters. On the day of the move to the Kokrail Cholera Camp, by a curious fatality "C" and "F" Companies were the first to start, and one of their filters was put up and in working order in the evening when the men of the other companies arrived hot and thirsty after their march. The men of these other Companies thus had an opportunity of drinking from this filter at this time and at no other time during the outbreak, and consequently on the second and third day afterwards they were more than decimated by the disease. It may be noted that there is reason for thinking that the incubation period of cholera is two or three days in the great majority of cases. Accepting this dictum, an examination of the list of daily admissions from cholera during this outbreak, leads one to suspect, that the greater part of the infection was taking place on two days; namely, on the day of move from barracks to the Preparatory Camp and on the day of removal from the Preparatory Camp to the Kokrail Cholera Camp. On other days during this outbreak the men were exposed to chill as there was exceptionally heavy rain at the time. But no evidence can be drawn from the curve of the epidemic that chill had to do with producing infection. I have no wish to deny that evidence of the predisposing effects of chill can be brought forward, but I wish to point out that all the evidence goes to show that infection took place at a time when the men had hard work to do and were consequently thirsty. It is noteworthy that at the time of the cessation

of the disease the report had spread among the men that it was due to water, and the consumption of water decreased, if it did not stop completely. Very large quantities of aerated waters were at this time drunk by the men.

It is a fact that cholera is more prevalent among British troops than among native troops while they are in barracks. The only so-called sanitary precaution that is applied to one body of men that is not applied to the other, is the filtration of water. The Commission of Investigation into the Lucknow cholera outbreak made the suggestion that we may here have to deal with a case of cause and effect. Another cause no doubt is the greater concentration of the water supply in British Regiments.

(4) *Example of cholera produced by food infection.*—During the summer of 1894 a virulent cholera epidemic occurred in Cawnpore that carried off 6 per cent. of the population. At the time that the epidemic was at its maximum, dropping cases of cholera occurred among the troops in the neighbouring cantonment. These cases did not constitute a definite outbreak, and I do not know that a definite explanation can be given of them. It is however extremely probable that they were due to accidental infection of food by the cook's mates and other servants employed in the regimental cook-houses. I examined one of these places and found that to all appearances it was perfectly clean and well kept. I took away with me specimens of everything I could possibly put into bottles, and the cholera microbe in a virulent condi-

tion was detected in water taken from a drain crossing the floor of the cook-house, on some chopped meat, and in some milk. The latter was not part of the usual supply for the regiment, but a cup of milk that had been put aside for the men on guard. The water used in the cook-house, the water used in the regiment, and all other sources of water near, were free from the cholera microbe, and the conclusion is inevitable that the above mentioned microbes had been carried into the cook-house by the cook's mates, who probably lived in the bazaar or in the town where cholera microbes were universally distributed.

(5) *Example of infection produced by means of flies.*—In October 1891 an epidemic of cholera broke out in Gya Jail. There were 26 attacks, and 17 deaths. Professor Haffkine arrived on the spot to carry out his anti-choleraic inoculations, and at the same time carried out bacteriological investigations with Surgeon-Major R. Macrae, with the object of discovering the course of the disease. It was found out that the water supply was free from the cholera microbe and other ordinary sources of infection were excluded. The only explanation of the epidemic that was found to fit the facts was that it was due to flies having carried the microbe from the dejecta of the patients on to the food. To test this possibility little pots of freshly boiled milk were placed in different parts of the jail. After a time they were examined. Certain of the pots were found to contain flies that had drowned themselves in the milk, and in these pots cholera microbe were detected.

(6) *Example of infection carried on clothes.*—I have to thank Brigade Surgeon Lieutenant-Colonel French-Mullen for communicating to me the following very striking case. I quote the following description from a tract on cholera that I have written for natives:—

“In the year 1889 cholera was very bad in Bussorah; so much so, that many people left the place in terror at the disease. One day a fisherman was walking through the town to the river where he purposed going on his boat. On his way he found a bundle of clothes lying in the roadway. Seeing that they were of value and thinking that they had been left by one of the fugitives, he took up the bundle and carried it with him. Having arrived at his boat he started on his journey of 50 miles to the village of Bariki where he lived. Four days later he arrived at the end of his journey. Finding that the clothes were female apparel he gave them to his women folk, who divided them among themselves. Four days later all of these women died of cholera. The fisherman himself was not ill, neither was anyone else in the village, but only those four women who had handled the clothes.”

(7) *Example of infection carried on milk.*—I have not been able to meet with a clear case of infection carried by milk. Even in the cases mentioned in Davidson's Tropical Diseases, it appears to me that the possibility of water infection was not rigourously excluded. The following case well illustrates the

difficulties attending sanitation in India. The water was shown with certainty to have had no direct action in producing infection. Two cases of cholera occurred among soldiers in Shahjehanpur Cantonments in August, 1895. It was found that the milkmen (*gwallas*) lived in a village in which cholera was prevalent and cholera microbes were detected in the milk. The strictest orders had been issued that the cows were to be milked under European supervision, and the milk was supposed to remain under such supervision from the time it left the cow till it was consumed in the different barracks. The following is the list of articles, sent me by Surgeon-Major Jones, A.M.S., examined in my laboratory in connection with this outbreak :—

	Cholera microbe was		
(1) Dejecta of first case	Detected.
(2) Specimen of milk used in coffee shop	„
(3) Specimen of milk sold in barracks	„
(4) Well No. 56½, near which cows are milked	„
(5) Water found in <i>gwalla's</i> house	„
(6) Water after use in washing up “H” Company's cook-house	„
(7) Well No. 1 <i>gwalla's</i> house, Dibarak village	„
(8) Food remains after cooking, coffee shop cook-house	„
(9) Well No. 56, supplies water for filter in barracks where case occurred	Not detected.
(10) Water from filter above mentioned	„
(11) No. 55 well used for cleaning purposes	„

- | | | | |
|------|---|---------|---------------|
| (12) | Water from filter in No. 3 Barrack | .. | Not detected. |
| (13) | Butter from coffee shop | " | " |
| (14) | Lemonade | " | " |
| (15) | Soda water | " | " |
| (16) | Water after use in washing up coffee shop cook-house | " | " |
| (17) | <i>Rubree</i> (sweetmeat) from Regimental Bazaar | " | " |
| (18) | Tank water, village Dibarak | .. " | " |
| (19) | Well No. 2 <i>gwalla's</i> house, Dibarak bazaar | " | " |
| (20) | <i>Nand</i> adjoining well No. 1 <i>gwalla's</i> house, Dibarah | " | " |
| (21) | Remains of food after dinner, H. Company's cook-house | " | " |

Though the evidence points towards the milk, it shows that it is also possible that the disease was introduced by the cooks owing to the cholera that was then prevalent in the neighbouring town.

(8) *Example of infection carried on fruit.*—I am indebted to Surgeon-Captain Clark, Officiating Civil Surgeon, Lahore, for the following very clear case of infection produced by means of fruit. In 1892 he was living in Dharmsala in a house with five other Europeans. No cholera was present in Dharmsala at the time. On a particular day, he, his son, and the *khitmatgar's* wife were attacked with cholera. Three days previously a basket of strawberries had been sent to the house from a tea estate in Palampore. On their way from this locality the strawberries were carried

through the Kangra Valley where cholera was prevalent. As shown by later developments, it is likely that the native who carried the strawberries had sprinkled them with water on the way, during the journey. On the day of the arrival of the strawberries, Surgeon-Captain Clark and his son came into the house before the rest of the family and finding the strawberries on the table, they both partook of them. Later on the strawberries disappeared, and no other Europeans in the house touched them. It is possible that they were stolen by the *khitmatgar* and given to his wife who, as already mentioned, was also attacked by cholera. In this case the water used in the house was above suspicion. It came from a spring in the compound situated above the house, and all the drinking water was boiled under European supervision. The milk was always boiled in the presence of the nurse. The immunity from cholera of the rest of the station gives strong presumptive evidence that other ordinary sources of infection were not efficient in producing these attacks. No other articles of food were ordinarily brought from Kangra Valley and strawberries were not an ordinary article of consumption in Dharmsala at the time.

CHAPTER IV.

PRACTICAL PRECAUTIONS AGAINST THE
SPREAD OF CHOLERA IN CANTON-
MENTS.

THE curious outbreaks of cholera described in the preceding chapter tend to show, that however capriciously the disease may appear to spread in Indian cantonments, it is safe to assume that infection is caused by swallowing the microbe either in food or water, as is the practically universal result of European experience. Our precautions then ought mainly to be concerned with preventing the access of the cholera microbe to the food or the water supply when cholera is in the neighbourhood, and in freeing the food or water supply of this microbe when once it has effected an entry into cantonments.

I. Precautions to be taken when cholera is about.

(1) *Persons returning from infected districts:* should not be allowed to go near the wells, or be allowed to handle other people's food. It is most important that they should have no chance of infecting the water supply. During the summer of 1891 in Lucknow, cholera was definitely proved to have been introduced by soldiers returning from

leave on several occasions. It only succeeded in spreading to other persons in one case in which the microbe reached a well (in whose water it was afterwards detected), and it did this and succeeded in infecting others in spite of the fumigation and whitewashing that no doubt took place in accordance with ancient custom. Obviously no difficulty need be found in preventing British soldiers from using a well. If he wants a drink he will get it from the *bhisti*. With natives on the other hand the matter is more difficult. In the case of a Mahommedan, he will readily take water from a *bhisti*, but care should be taken that he does not lower his *lota* into a well to get water for purposes connected with defecation. The objectionable part of this practice is that it may easily infect the *lota*, that afterwards he will come back to the well, pick up a handful of earth, use it to scrub the *lota*, and then lower the muddy *lota* into the well again and shake it about in the water in order to clean it. It is much more easy to point out this danger than to suggest a remedy for it. No doubt officers in native regiments are much better qualified than I am to devise measures to avoid the risk. I feel sure that the danger can not be avoided by simply issuing an order that natives are not to wash their *lotas*. In such a matter due regard must be had for native customs. In the Lucknow Sadr Bazaar (which by the way is a place exhibiting a curious case of "local immunity" against cholera) I noticed attached to several

wells a tank that was closed in except at one place near the top of one of the sides. Through this an attendant poured in water, and persons requiring water for the above-mentioned purpose were in the habit of drawing it from a spout closed by a cork situated near the bottom of the tank. In this way *lotas* could be cleaned without any risk of infecting the water in the well. But these wells were only used by Mussulmans, and I doubt whether Hindoos could be prevailed upon to use such an arrangement even if three spouts with taps were provided, of which one could be used by high caste Hindoos, another by low caste Hindoos, and the third by Mussulmans. Although low caste Hindoos will clean their *lotas* by the above-mentioned method after defecation, no high caste Hindoo would dirty his well in this way unless he was on a pilgrimage. High caste Hindoos keep a special *lota* "*tatti-ke-wasti*" out of which they will not drink, neither will they lower it into a well. When requiring water for defecation they first draw some in an iron *dol*. From this they fill their *lota*, and hence the risk of infection if the well is avoided to a great extent. The chief difficulty is with low caste Hindoos and native Christians. The former may profess to follow such caste customs as those above described, but are very likely to neglect them if no one is looking. Probably the best method would be to take care that all natives for a week after their return from an infected district should only be allowed to use

a latrine for purposes of nature, and that they should only be allowed to take water in their *lotas* for this purpose, or for cleaning them ; either from a *bhisti* in the case of Mussalmans, low caste Hindoos or native Christians, or from a *kahar* or Brahmin, if they are Hindoos of higher caste. Possibly natives might be encouraged to fall in with this arrangement by confiscation of their *lota* ropes. It is quite out of the question to attempt to disinfect *lotas* by means of ordinary disinfectants. But as above stated the cholera microbe can be destroyed by exposure to the sun or by drying. An order to expose the *lotas* and their ropes in the sunshine for several hours every day would conflict with no native prejudice, and would certainly free these vessels from cholera microbes during the hot weather. Unfortunately this method can scarcely be relied on during the rains, when the sky may be overcast and the air charged with moisture. Cholera in the North-West Provinces shows more tendency to spread at the time of moderate rainfall, apparently owing to dampness favouring the vitality of the cholera microbe.

Some good may be done by the erection of "*piaous*" or drinking places. In many parts of the North-West Provinces and the Punjab, it is customary during the hot weather for wealthy natives to erect by the side of the road at the entrance to their town or village, a small grass hut provided with a window. Under the window a spout of bamboo will be fixed. Inside the hut is

placed a Brahmin who dispenses water free of cost to passers by. If the traveller is of high caste, the water is poured from the *lota* into the man's upturned hands. Care is taken that the *lota* is not touched by the stranger. If this happened the *lota* would be regarded as defiled and would have to be heated in the fire before it could be used again. But if the traveller is a low caste man, such as a sweeper, there is a risk that drops of water might splash back on to the *lota* from the man's hand. This would defile the *lota*. Hence in giving water to the sweeper, it is poured down the spout and the sweeper has to drink by catching the water in his hands as it issues from the lower end of the spout. By this arrangement it is rendered impossible for the traveller to infect the well water, as there is no need for him to lower into it his possibly infected *lota*. On the tonga road from Simla to Kalka, I noticed a modification of this plan. At intervals may be seen three sticks each about two and a half feet high planted in the ground side by side. At the top of each stick fixed at right angles to it will be noticed a spout made of split bamboo. Passers by drink from these spouts. One is reserved for high caste Hindoos, another for low caste Hindoos, and the third for Mussalmans. On the same road near a cantonment, I noticed a native washing a dirty dish cloth in a bowl of milk. The former arrangement illustrates the native's idea of sanitation applied to himself. The latter incident illustrates his idea of sani-

tation as applied to British soldiers, for I do not believe that natives would treat milk in such a way if it was intended for themselves. I believe that the presence or absence of these "*piaous*" have something to do with the facts of the spread of cholera. I have elsewhere suggested that the reason why pilgrims are more efficient in spreading cholera than ordinary travellers, is that the former do not in many cases use "*piaous*" owing to their numbers, while the latter use "*piaous*" while travelling in the hot weather and thus there is little risk of their infecting the water supply till their arrival at their homes.

The erection of "*piaous*" in cantonments may be useful as a means of preventing the spread of cholera, especially on those days on which any fair or market is held in any part of the bazaar, and secondly, at all times near *serais*. Travellers staying in these *serais* should be encouraged to obtain their water from "*piaous*" only. There is a greater chance of natives falling in with this sanitary precaution, than with the alternatives I suggested above, as paying Brahmins to draw water is regarded as an act of piety and charity.

(2) *Cooks and cooks' mates* are just as liable to introduce the cholera microbe into the cook-house as returning pilgrims are into their villages. Hence the greatest care should be taken to prevent infection of the food of Europeans and soldiers. The cooks' mates employed in European regimental

cook-houses are, I believe, the dirtiest people in India, and thus the most liable to carry about with them infectious matters. The most obvious remedy for this state of affairs is to clean these cooks. I do not think that this can be done simply by issuing an order that they are to wash. If the cooks' mates are Mahommedans, it will be noticed that they wear *pyjamas*. If they are Hindoos, they wear *dhoties*, or loincloths, which are nearly always insufferably dirty, and in a corner of which they will either boil a pudding or strain the soup as occasion arises. If a respectable Hindoo is noticed when he is washing at a well, it will be seen that he takes off one *dhoti* and puts on another. The discarded *dhoti* is washed and dried. All Hindoos, except those of the lowest castes, and most servants of Europeans, own a pair of *dhotis* and wash and change these articles of clothing at least once every day. Mahommedans on the contrary wear *pyjamas*, which do not adapt themselves so readily to this out-of-door ablution. They do not wash as a rule so often or so extensively as Hindoos, neither do they so often change their clothes. Hence I suggest that no one employed in a cook-house should be allowed to wear *pyjamas*, because the *dhoti* is a garment that lends itself more readily to personal cleanliness, whatever effect it may have on the cleanliness of the wells. It would be advisable to provide a pair of *dhotis* for each *masalchi*, or cook's mate. They should have a coloured margin so that they can be easily recog-

nised. An order should be issued that no native is to enter the cook-house on his return from the town or bazar in the morning until he has bathed at a well that might be set apart for the purpose. Naturally it would be necessary that this operation should take place under the eyes of the orderly appointed to look after the cook-house. After bathing, the *dhoti* that is taken off could be washed and spread out in the sun to dry, and the cooks' mates should be forbidden to bring either a *lota* or a *huka* or any clothes except the *dhoti* they are wearing into the cook-house.

An objection to such a plan would be that the cooks' mates would in all probability infect the well. If a *bhisti* then, to save himself trouble, was to fill up the barrack filters with water from this well, the consequences might be disastrous. This risk may be avoided by adding to the water every day one or two ounces of potassium permanganate. This will only cost two or three annas per day. The water will thus acquire a dark purple colour and no *bhisti* would venture to have anything to do with it. The permanganate would have the advantage that to some extent it is an antiseptic and has the power of destroying organic matter. The disadvantage would be that it would gradually colour the *dhotis* a dark brown colour, and thus make it difficult for the officer inspecting the cook-house to see if they are clean. The brown stain made by permanganate can be easily removed by washing in a solution of sulphurous acid. Posionous

or strongly tasting antiseptics would be objectionable, as the cooks would use them to flavour the food if they did not approve of the arrangement. Quicklime might be employed, but it would then be difficult to know whether it had been used in the filters.

Having washed the cooks, it remains to prevent their having any connection with the bazar during their day's work. It frequently happens that their relatives bring them their mid-day meal from their homes. This they commonly eat outside the cook-house under the shade of some convenient tree. They will not eat their food inside an English cook-house, as they consider they would be defiled by so doing, a prejudice not without some foundation. They will however drink tea there, a custom that should be stopped, as it leads to confusion between the milk they have brought for the purpose from the bazar and the milk brought for the soldiers from the Regimental Dairy. A free ration of milk from the dairy for the cooks might prevent accidents from this cause.

During cholera times it would be well to provide outside each cook-house a grass hut, which could be built for a couple of rupees, in which the cooks could keep their clothes, *hukas*, &c., and eat their food. They should be forbidden to bring any cooked food from the bazar, but should be encouraged to build fireplaces (*chulas*) at which they

could cook their mid-day meal. It would be an advantage if dry grain or flour, &c., could be provided for them for this purpose. Possibly some difficulty may be met with in carrying out these suggestions, but it appears to me that any successful attempt to keep the cooks away from the bazar, when there is cholera there, would be well worth the trouble.

(3) *Dish cloths or jharans should be disinfected* on their return from the wash by boiling in a *degchie* for half an hour. *Jharans*, especially in the rains, are often brought back from the wash positively stinking. This is due to the fact that the *dhobies* wash them in pools of stagnant water. I have found *dhobies* washing clothes in a stagnant pool in a *nullah* in which I detected the enteric microbe. Possibly if the *jharans* were washed in such water and then used by the cooks to strain soup, the latter might be infected by the enteric microbe. The enteric microbe is not readily destroyed by moderate heat, and I suspect that often the temperature of the soup would not be sufficient for this purpose. The cholera microbe is more easily destroyed by heat, and hence with this microbe such an accident is less likely to happen, but *jharans* are used for many other purposes, and many ways by which they can introduce dangerous microbes into the food may be conceived. The custom that exists in some regiments of providing no *jharans* for the cooks, does not appear to me to present a satisfactory escape from the above danger, as it results in the cooks

using portions of their old clothes for the purpose. Flour, spices, sugar, and other articles of food may be seen in cook-houses wrapped up in pieces of dirty rag, which probably have not been washed since they functioned as part of the cook's loin-cloth.

(4) *The floor of the cook-house should be daily washed with an antiseptic solution.* Chloride of lime (also called chlorinated lime) is the most energetic disinfectant that can be safely used in cook-houses against the cholera microbe. A quarter of a pound should be added to each bucket of water. This substance has the disadvantage that it does not keep well in the Indian climate. Quicklime may be employed in the proportion of half a pound to a bucket of water, or as recommended in Appendix II. It has the disadvantage that if it is not fresh, it is of no use, and that it absorbs carbonic acid from the air which changes it into a compound (carbonate of lime or chalk) which has no antiseptic action. There are always holes in the floor of a cook-house in which dirt accumulates. A mixture of dirt and lime in such a hole, will after a time lose its antiseptic properties, and might thus change into a suitable *nidus* for the cholera or other microbe. If afterwards the cholera microbe reached such a position, it might breed there, and then be carried by flies, &c., on to the food. Such an accident would be less likely to happen with potassium permanganate, as it has the property of destroying many kinds of dirt, and

hence I consider it a satisfactory disinfectant for the purpose. It may be used in the proportion of half an ounce to a bucket of water.

(5) *The most important point to pay attention to is the water supply.* In the case of Municipal water, it is not likely that it will become infected with the microbe of cholera, at any rate till after it has been drawn from the standpost. In Agra, I have found that the Municipal water actually acts as if it were a feeble disinfectant to the cholera microbe when in a test tube, though not when it is in a Macnamara Filter. It sometimes happens, especially in places in which the Municipal supply has but recently been laid on, that the water coming from the standposts is found to be turbid. Whether or not this is due to a break-down of the filters, may probably be learnt by enquiry from the Engineer in charge. I believe that as a rule it is due to dirt that was present in the pipes at the time they were laid down, being suddenly taken up and carried into circulation. This may happen owing to some sudden change of pressure, or of the speed at which the water flows. In the cases with which I am acquainted, there is no reason to think that the change was accompanied by any danger to the consumers of the water.

If the water supply is from open wells it is advisable to remember that they are liable to contamination at any moment. If the supply comes from efficiently closed in wells, they are only liable

to contamination once a week, when a coolie goes down the well to oil the pump, or if there is an attached filter at the time that coolies clean it out. Practically always, (my experience is limited to the North-West Provinces) contamination of a well is due to direct human agency, and not to leakage from a drain, but the latter eventually should be borne in mind if the well is badly situated.

Hence in the face of a threatened cholera epidemic, do not rely on the reports of persons like myself that the water of the well is "fit for potable purposes." It is a fact that if the natives happen to have the same opinion as the Chemical Examiner that the water of a well is good, they may send from long distances to fetch its water, and the well is for this reason more liable to contamination with cholera microbes. It is not a proved fact but a speculation, though a probable one, that the water of a good well furnishes less food for the cholera microbe than does that of a bad well, and hence it is probable that the water of a dirty well is the more dangerous when once infected.

The following precautions may be suggested as worth taking if cholera is about. Firstly, if the well is closed in, take care that no one is allowed to go into it to oil the pump except a healthy and clean European ; do not clean out the filter. If it is open allow no one except recognised *bhistis* and water-drawers to draw its water. Forbid any ablutions on or near the platform of the drinking

water well. Remember that the *bhisti* can only draw water for Englishmen, native Christians, Mahomedans, and low caste Hindoos. Water for high caste Hindoos can only be drawn by a native, either of Brahmin, Kahar or a few other castes. Either such a water-drawer should be provided, or a well should be set apart for the use of high caste Hindoos. Potassium permanganate might be used to destroy organic matter in the water of a well, and in this way may possibly render the water unfit to support the life of a cholera microbe that may subsequently get into the well. This, however, is only a probability and not an ascertained fact.

A great danger consists in stagnant or dirty wells that are but little used. If a shower of rain is followed by a cholera outbreak, do not spend much time in speculating on the possible relation between cholera "and oscillations in the level of the subsoil water," but rather suspect that because it was raining, the *bhisti* did not care to walk to the good well at a distance, but went to a nearer and dirty well, whose water was not usually put into the domestic filter. A few days before writing this paragraph, I had to deal with a case in which the enteric microbe was detected in the water coming out of a Macnamara filter, while it was certainly absent from the water that was supposed to be poured into it. The Medical Officer in charge is of opinion that this was due to the *bhisti* having filled his *mussack* with water that according to

orders ought only to have been used for washing-up purposes. As above suggested such a danger can most readily be avoided by keeping sufficient potassium permanganate in the water of such washing-up wells as to make it impossible for any one to use them for drinking purposes. Such treatment will not interfere with the use of the water for washing purposes, but rather the reverse, while the *bhisti* will probably be afraid to put the "red medicine" into the filter. Another point to which attention may be drawn is the possibility that dirty water is used in the *musalchikhana* for washing up plates and tumblers.

II.—PRECAUTIONS TO BE TAKEN ON THE APPEARANCE OF THE FIRST CASE.

(1) Send a specimen of the dejecta (not the vomit) for bacteriological examination, in order to learn whether the case is one of true Asiatic cholera or not. This test is universally considered necessary, both by the Local Government Board in England, and by all authorities on the continent. No doubt doctors in India can readily tell as a rule whether a case is one of cholera or not if it occurs during a cholera epidemic, but decision about isolated cases is far more difficult, and as above stated cases of so-called "sporadic cholera" may really have nothing to do with the cholera microbe. A very small quantity of dejecta is generally sufficient for the examination.

(2) Send specimens of the water drunk in the locality, and also of the water used for washing purposes if they have different sources. This should be done even in cases in which the patient denies that he has drunk any water, as it is desired to learn whether other persons residing near are in danger from this possible source of infection.

(3) Arrange to have the dejecta disinfected. Corrosive sublimate is of comparative little value for this purpose. Acids, either sulphuric or hydrochloric, may be used. Copper sulphate (vernacular "nila tutiya") has the merit of being readily obtainable. A solution of one part in 500 should be prepared and added in equal proportions to the dejecta. The danger from dejecta is two-fold. Firstly, handling them may lead to a transmission of the infection. Hence burning or boiling them is objectionable because it involves handling. Secondly, flies may settle on the dejecta and carry away the microbe. Hence disinfectants having disagreeable smells are advantageous, as they tend to discourage the attendance of flies. Chloride of lime or carbolic powder may be recommended. If a mass of dejecta have soaked into the earth or into a mattress, there is no need to treat the microbes it contains as if they were endowed with a measure of immortality. The cholera microbe under such conditions will die out, or at least become harmless of its own accord within a few days. All that is really necessary is to be sure that the microbes on the surface are killed, and that the dejecta are otherwise left alone,

so that the risks of the microbes being carried away by flies or by handling may be obviated.

(4) All persons coming in contact with the patient should disinfect their hands frequently. This is especially necessary before eating. Strong carbolic soap is the best disinfectant for the purpose. So far as possible food should not be eaten anywhere near the patient, neither should any, besides the patient's food, be brought near him. "Boric lotion" should be distrusted.

(5) All wells should be disinfected. There can be no question as to the utility of doing this, but which is the best method to employ is still a matter of experiment. At present I believe that permanganate of potassium is the best suited for the purpose. Condyl's Fluid is a solution of this substance (or of the allied sodium permanganate) in water. It is preferable to use the solid substance not only because it is cheaper, but also because the caste feelings of natives are less liable to be hurt by the addition of a solid than a liquid to a well. For village wells I recommend that enough of the solid permanganate should be added to the well to give a faint purple colour to the water lasting for several hours. Generally an ounce of the permanganate is enough for the purpose. Permanganate destroys dirt and is destroyed by it; hence when added to a dirty well the colour will quickly disappear and it will be necessary to add a further quantity. It is advisable not to add more than

will give a faint permanent purple colour, for if a strong colour is produced, the water will be so unpalatable that no one will be able to drink it, and there would be a risk of the villagers going to other not disinfected sources of water which might lead to disastrous results. It is advisable to add the permanganate in the evening so that the well water will remain undisturbed as long as possible. The water will be fit to drink on the following morning. In cantonments on the other hand a different procedure may be adopted. Larger quantities of permanganate may be employed, perhaps six or eight ounces per well. An hour or two after this quantity has been added, the water may be pumped out, until only a faint purple colour remains. The water may then be regarded as fit to drink. Closing a well even for a few days should be avoided, provided disinfection can be carried out. If cholera is a water-borne disease, surely it is an advantage that the water supply should be as divided as possible.

Not only wells used for drinking purposes, but also those used for washing-up purposes, and those that are not used at all should be disinfected.

(6) *Soldiers should be warned against drinking water, and recommended to use aerated waters, tea, &c.* It would be a great advantage if the price of aerated waters supplied by the regimental sodawater factory could be lowered at a time when cholera is about, or if a certain number of bottles could be supplied free to the men. Care

should be taken that the men can obtain aerated waters not only in the coffee shop and canteen, but also in their barracks. Even the Army Temperance Association should be recommended to drink no water. In a recent epidemic among British troops that came under my notice, 14 out of 16 men attacked belonged to the Army Temperance Association. Soldiers often keep a small *gurra* of water under their beds during the hot weather, out of which they can take a drink if they wake in the night thirsty. If aerated waters could be supplied free of charge during a cholera epidemic, it would be an advantage to break these *gurras*.

Boiled water is absolutely safe. It is only necessary to boil the water for a few minutes. The good effects of boiling may be removed if the water is afterwards filtered, or if it is poured into unclean vessels such as the above-mentioned *gurras*. Care should be taken about the water in which glasses are cleaned behind bars in clubs, canteens, &c. Generally the attendants make one small basin of water last for the whole day. Any risk from this source can be avoided by adding to this water a few drops of sulphuric acid.

The following example illustrates the use of boiled water. In January, 1893, a cholera outbreak happened in the Nettleben Lunatic Asylum. Its cause was traced to the water, and then only boiled water was given to the patients to drink. Immediately this was done a great diminution in the numbers of cases occurred. The disease however

did not completely stop. Then it was discovered that in spite of the orders to the contrary, some of the attendants were in the habit of turning on the water-taps in their wards. The keys for the water-taps were immediately taken away, but still a few cases occurred, some of which may have been due to accidental infection of food, &c., but some of which appears to have been due to the patients having drunk the water in the water closets. These sources of infection were put a stop to and at length the disease apparently ceased. A few days later however another case occurred. It was discovered that an attendant when going round to light the gas, noticed that there was a disagreeable smell in the urinal. Seeing that the place needed cleaning, he turned on the water with the key intended for the gas-tap, which by an accident also fitted the tap for the water. A lunatic, on the look-out for his favourite beverage, rushed into the urinal, and took a drink of the infected water with the usual unfortunate consequences. After this carbolic acid was pumped into the water-pipes to disinfect them, and the disease immediately and permanently stopped. It is noteworthy that in this epidemic the one precaution that was necessary and efficient in stopping the epidemic was removing the infected water.

Empty sodawater bottles from a hospital or a cholera camp may safely be sent back to the hospital for refilling, if they are first thoroughly dried or washed with any acid solution. Dilute sulphuric

acid is the best for the purpose in the proportion of one part of the acid to 1,000 of water. In the factory itself it might be well to arrange that a small quantity, say half a cup full of sulphuric acid, should be added to the tub of water in which the bottles are washed. In Lucknow in 1894, I once found the cholera microbe in the washing up water in the sodawater factory of one of the regiments. There is no reason for thinking that it did any harm there, as the regiment in question remained free from the disease. The water-supply in the regimental lines was free of this microbe, and there is no doubt that it had been carried into the soda-water factory from the neighbouring town where the disease was prevalent by the coolies employed in washing the bottles.

(7) *If a case of cholera occurs in a native house in cantonments, what should be done?* Should it be fumigated, and should the inhabitants be turned out? My answers to these questions may perhaps expose me to criticism, but I venture to ask would be critics to remember, firstly, that medical officers and even commanding officers are apt to be overworked on the appearance of cholera, and hence it is advisable that the precautions against cholera should be as simple as possible, and secondly, the average native's idea of sanitation is that it is merely a means of paying off a grudge against his neighbour by finding that he has a smelling drain and lodging a complaint about it. Hence precautions that trouble him are very apt to lead to a concealment of cases.

In old times when the nature of cholera was not properly understood, this was not a matter of great moment, but nowadays when we understand the causation of epidemics of cholera not completely, but probably better than we do those of any other disease, it is in the highest degree important that medical officers and sanitary officers should have fair opportunities of applying this knowledge. It sometimes happens that pilgrims are accused of spreading cholera, when no cholera is known to have occurred at the fair from which they came. How this interesting fact might modify our ideas of the causation of cholera epidemics, if we could feel any confidence that it was not due to concealment of cases ! The Sudder Bazar in Lucknow has shown immunity from cholera so far back as statistics go, although on several occasions the disease has been raging either in the neighbouring town or in the surrounding cantonments. Might not this fact stimulate one to researches on mysterious influences of locality hostile to the infection of cholera, could one have any certainty that it was not due to the shop-keepers there, putting on to an *ekka* any cases that may occur and sending them away to the native town, owing to their wishing to avoid the risk of being put out of bounds ? A case has come under my observation in which an outbreak of cholera causing the death of 300 persons happened a few miles from where a *mela* was being held, and which was concealed from the authorities

for one at least, and possibly three days, though they suspected its existence and attempted to find out the truth.

So long as natives are convinced that our sanitary precautions are powerless to check the march of the disease, and only result in trouble to themselves, so long will this sort of thing be likely to happen. It is a fact that cholera affects European troops more severely than native troops while they are in barracks, though the relative susceptibility of Europeans and natives appears to be reversed in the surrounding populations. The severity that cholera sometimes shows among British troops is well known and has become proverbial among natives.* Until this state of affairs is changed, and until we can point to the immunity from cholera of those who are most carefully sanitated, we shall

* In these days when existing regulations have done so much good in limiting the ravages of cholera, it is difficult to realize the virulence that this disease used occasionally to assume among British troops. The following description of an epidemic is quoted from Davidson's "Diseases of warm climates," page 369 :—"In one regiment out of a total strength of 1,002 men, 863 were employed as hospital orderlies ; and of these no less than 428 were seized with cholera..... And what is more remarkable, when it was discovered that the European orderlies were unable to work any longer, some thirty Sikhs of the 31st Regiment were daily sent to take their place in the European Hospitals, but not a single instance of cholera occurred among these natives."

Now that we know that cholera is generally transmitted by means of water the supposition may perhaps be allowed that these men escaped owing to their caste prejudices preventing their using the water in the hospital filters.

be unable to convince natives of the value of Western ideas in combating this Eastern scourge. Until this happens we may be sure that any precaution that interferes with native customs or prejudices will either not be observed, or will become merely a means of extortion by the police, or will lead to concealment of cases. The other day I was talking to a municipal secretary, a native, whose efforts in persuading his fellow townsmen to adopt the new municipal water-supply have been most commendable. To all appearance he is thoroughly imbued with Western ideas and with apparent enthusiasm is elaborating a sewage scheme which for the town in question I believe to be unnecessary.⁽⁷⁾ Nevertheless he confided to me

(7) There is an excellent system of surface drainage in the town in question which I believe is not used so much as it might be, because it leads into the river. Most of the filth is carried away from the houses of high caste Hindoos by sweepers. No doubt the natives really employ the sweepers because their forefathers did so, but I was informed by a native that the reason why they did not let any filth get into the drains was that they led to the river and that the river was sacred. Needless to say the main drain opens into the river at the middle of the bathing ghat, so that the practice of keeping dirt out of the drains has some advantage.

A native of this town, who has enjoyed the benefits of an English education and holds a responsible position, tells me that since the pipe water has been introduced there are only 10 per cent of the men in the town who do not suffer from indigestion and only 5 per cent. who do not suffer from gonorrhoea. This man is firmly convinced that cholera and fever have increased owing to the efforts of sanitary authorities, and I have no doubt that his English education would enable him to express these views in Johnstonesque English, and to adorn his statement with quotations from Shakespeare and Chaucer in a way that no mere sanitary expert could attempt to rival.

that well-water had been good enough for his forefathers, and he saw no need for replacing it by municipal water, which, though it might suit European constitutions, was productive of fever and indigestion among natives. Supposing (as is not likely) the order is transmitted through this man that all cholera corpses are to be cremated, is it not probable that he will notice that European officials make no effort to apply this rule to Europeans and that he will merely make a profit on the fuel that will be stated to have been consumed, and possibly take a fee from those who prefer to cast the bodies of their relatives into the waters of the sacred Ganges?

Supposing cholera to occur in a native house, it should be visited by a European officer of experience. He should take with him fuel, disinfectants and a large iron vessel in which clothes may be boiled. He should regard the following things as dangerous, the patient, his dejecta, the food and water that may be present in the house, the cooking vessels, the place where they are washed up, the corpse of the patient if death ensues, and the patient's relatives. We will consider these points in order.

(a.) If possible the patient should be persuaded to go to hospital, unless he seems likely to die immediately. But I consider that the advantages of thus isolating him are not equivalent to the evils inseparable from any compulsion.

(b.) The dejecta are only dangerous while they are damp. So soon as they are thoroughly dry

they are harmless. While the patient is in the house it is advisable to disinfect them with liberal supplies of carbolic powder or chloride of lime. As already mentioned, these smelling disinfectants are preferable as they are more likely to discourage the attendance of flies. So soon as the patient has gone, a further treatment of the floor may be undertaken. The floor may be disinfected either by covering it by burning charcoal until it is well dried, or if it is very moist, it may be better to sprinkle it with carbolic powder and then to cover it with a layer of dry earth which should be 2 inches thick after it has been well stamped down.

The mud floor should *not* be dug up for a depth of several inches and then carried away. It is possible and probable that dejecta containing cholera microbes have soaked into the floor and that the burning or disinfectant powder may only affect the microbes near the surface. But we now know that these microbes beneath the surface will die in a few days of themselves, and so long as they are in this position they are out of the reach of mischief. That the floor should be impregnated with decomposable organic matter is objectionable on general sanitary grounds, and it may be well on this account to dig it up and to renew it afterwards. But this should only be done three or four weeks after the cessation of the outbreak. If it was done at the time, there would be a liability of infection of the coolies engaged on the work, and many opportunities would be

given for flies to carry away the infective matter and to deposit it on food in neighbouring houses. That this possibility is an actual danger is illustrated by the following incident kindly communicated to me by Surgeon-Major Lukis. In 1887, at a time when no cholera was present in or near Jhansi, a railway servant returned to that place from Mahoba, where cholera existed. Shortly after his return he was seized with cholera and died. He lived in the servants' quarters, and shortly after his death two coolies were employed to dig up the earth from the floor of his hut and to carry it away. Within three days the two coolies were seized with cholera, while in their quarters. They became the focus for a small series of fresh cases which was confined to the coolies' lines. No further cases occurred in the servants' quarters, where the infection had first been brought.

(c) It is possible that food present in the house may have become infected by means of flies or by human handling. All cooked food and sugar found in the house should be destroyed by burning. There is little need to apply this rule to dry grains which are likely to be cooked before use. The inhabitants should be advised to bring no cooked food from the bazar, but only to eat food that has been freshly cooked by themselves. Sugar and sweetmeats should be discouraged, as they attract flies.

(d) Any water found in the house (except holy water) should be thrown away, and replaced by

water drawn from a disinfected well or by pipe water. Water found in brass vessels is used for drinking purposes. The vessels containing it are (in Agra) called *kulsas*, if as large as a man can carry, or *toknas*, if larger. These vessels should be put on the fire and a little water boiled in them in order to sterilise them. Water found in earthen vessels among higher caste Hindoos is not used for drinking, but only for washing up purposes. If it is not found convenient to sterilise these vessels by heat, it would be better to break them.

If the inhabitants have not had warning of the coming of the Inspecting Officer, he may find pots of holy water. These should in all cases be left alone. In the case of Hindoos the holy water is probably brought from the Ganges and kept in glass bottles. I have on other occasions given reasons for thinking that this water does not cause cholera outbreaks. If it were possible to persuade the inhabitants to drink Ganges water and nothing else, I am sure advantage would result at any rate in respect of cholera. In the houses of Mahomedans little tin vessels known as *dibias* are often kept, containing water from the holy Zem Zem well at Mecca. Possibly this water in Mecca has something to do with the outbreaks of cholera that have happened in that town, but I do not think it can be regarded as a likely source of infection in India, for the simple reason that it is not probable that well water should keep the

infection during the long journey to India when sealed up hermetically as is the case with the Zem Zem water. As a matter of fact, I have examined the Zem Zem water on several occasions, and twice I have detected in it the cholera microbe ; but in such a degenerated state, that I believe it was quite harmless to human beings.

(e) *Lotas* and cooking vessels should be disinfected by heat. On no account should antiseptics be used for the purpose (save them for the finger-bowls in the Officers' Messes), and on no account should the vessels be touched by a European. Unless these precautions are taken to avoid hurting the feelings of natives concealment is certain to occur. In the hot weather if the cooking vessels are clean, drying by exposure to the sun may be sufficient to disinfect them. A better method would be to put them in a fire. This can be done with vessels of earth, iron or brass. Certain *lotas* and other pots may, however, be made of bell-metal or other composition (vernacular *kànsa*) which would be harmed by placing in the fire. These must be disinfected by pouring into them hot ashes. It is necessary to ask how many women and children there are in the house, as there will be at least one *lota* for every person who is old enough to drink water, and if this precaution is not attended to, concealment of *lotas* may take place. It is advisable not to put any sulphur into the fire, as if this is done, not only will it incommode the residents in the house, but they are likely to object to put their

cooking vessels and *lotas* into a fire into which medicine has been poured. It is not necessary to heat the vessels to redness, because thorough drying is enough to kill the cholera microbe.

(*f*) If the house is built round a central court, probably in one corner of it will be found the place where the women of the household are in the habit of washing up the cooking vessels. This probably leads to a dirty drain which should be thoroughly disinfected with carbolic powder or chloride of lime. Drains outside the house should also be disinfected with carbolic acid or quicklime.

(*g*) The clothes of the patient should not be burnt. The custom of doing so is a bit of medieval hygiene by which perhaps a thousandth part of the microbes coming from the patient may be destroyed. The custom is an excellent one for allaying panic, as it is apt to lead to an extensive concealment of cases, but this is scarcely good sanitation. The clothes can be easily and safely freed from the infectious agent by boiling in water. Those who handle the clothes should be obliged to disinfect their hands. A few minutes boiling is enough to destroy the microbe, but if the clothes are bulky it would be well to leave them in the heated water for half an hour or more according to circumstances, in order to be sure that the heat has penetrated every part. Infected *rezais* or mattresses had better not to be boiled, but should be sprinkled with quicklime or carbolic powder and then exposed to the sun in a dry place for several days.

(h) *The disposal of the corpse.* With the exception noted below, the funeral customs of natives had better not be interfered with in any way during a cholera epidemic.

If the deceased is a Mussulman or a European, his body will be buried. It is absolutely unnecessary to put antiseptics in the grave, as the cholera microbe is known to die within a few days when buried in a corpse. In support of this statement I may quote the following facts:—I have examined the soil of a cholera camp within a few weeks of the departure of the affected soldiers, without finding a trace of the cholera microbe, though the soil examined was taken from the site of the hospital tent, and had no doubt been impregnated with the discharges, and although my observation was made in the rainy season of the year when there was little chance of the microbe having been destroyed by drying. I have also examined the soil within two feet of a drain near Daraganj, without detecting this microbe, although it was present almost to the exclusion of other microbes in the drain itself, and although the drain was running through marshy soil. The only case in which I ever found cholera microbes in the soil was in the immediate neighbourhood of my laboratory, at a place where water from two Macnamara filters had been discharged every day for a month previously. I had previously put the microbe into these filters and it had been breeding there during this time. An attempt to disinfect the large quantity of water

coming from the filters (about 120 gallons per day) had been beyond the resources of my laboratory, and I had had to rely on the purifying influences of air and sunlight. A buried cholera corpse is less likely to act as a breeding place for cholera microbes than a filter, because the organic matter it contains will support the life of anaerobic microbes which are with little doubt hostile to the life of the microbe of cholera.⁽⁸⁾ Petri during five years carried out observations on the fate of microbes in buried corpses. He found that in a corpse the cholera microbe vanishes within 19 days, and is already difficult to detect after 12 days. In the Indian climate the period is likely to be shorter.

With regard to the death of a Hindoo, there is little more to be done than to ensure that the native customs are properly carried out. The customs differ slightly in the different castes, and some of them appear to me to be mere ceremonies of no sanitary value, but a large number appear to be have a distinct sanitary tendency.⁽⁹⁾ For instance, the corpse is burnt as soon after death as possible. The bedstead and clothes used by the

(8) Petri : " Versuche uber das Verhalten der Bacterien des Milzbrands, der Cholera, des typhus, und der Tuberculose in beerdigten Thierleichen," Arbeiten aus dem Kais Gesundheitsamt, Vol. VII, part I, p. 1, and reference in the Centralblatt fur Bacteriologie und Parasitenkunde, Vol X, p. 125.

(9) The following account of Hindoo ceremonies is chiefly based on statements, information kindly given me by Baij Nath, Officiating Sessions Judge, Agra.

deceased are given to the sweeper. I am told that in the sacred books, the Shastras, it is enacted that they should be burnt. The clothes taken off the patient, are similarly treated. The earthen vessel used by the chief mourner in washing the corpse is broken. After burning the corpse all the mourners have to wash themselves and their clothing. If possible this is done in a river. In the meantime the women have washed out the house and covered the floor with a layer of the mixture of mud and *gobar* that is used for covering fire-places and similar purposes. For the next ten days the relatives are regarded as unclean. They are not allowed to associate with any one. No one will eat with them or touch their drinking vessels. They are not allowed to shave. Thus there is less risk of the infection being transmitted to others by means of the barber. They are supposed to eat simple food. They use no *betel*. Thus the family *betel*-box is the less likely to become a medium for transmitting infection. The chief mourner, whose duty it was to prepare the body for burning, is considered more unclean than the rest. He is supposed in some castes not to smoke during this time. He is obliged to bathe twice daily in the river. For the first three days the business of the deceased is closed. If the business is that of a *hulwai*, or sweetmeat-seller, there is little chance that much trade will be done, for so long as the relatives are unclean they are not allowed to wear a *puggri*, or other clothes than the *dhoti*. Any one

seeing them thus dressed and unshaved will at once recognise that they are unclean and will buy no food at their shops. It is even considered unlucky to return their salute. While they are unclean they are not allowed to send their clothes to the wash. Hence the chance of the *dhobi* transmitting the infection is minimised. On the tenth day the period of uncleanness comes to an end. The relatives wash the floor and whitewash the walls. They are then allowed to put on new clothes. On the thirteenth day a feast is held. In lower castes who are less careful about their personal cleanliness the period of uncleanness is longer. On the day of the feast a large fire is lit in the centre of the courtyard of the house. All earthen vessels in the house are thrown away or broken. All brass cooking or drinking vessels are sterilised by having hot ashes poured into them, or if they can stand it they are placed in the fire. A certain number of brahmins are invited to the feast. The food is cooked by *hulwais* engaged for the purpose. Everything has to be eaten from new vessels which have not been used before, and which after the feast are taken away and broken. It is obvious that of all these customs the only one that is objectionable is the funeral feast. If held when cholera is about it might well lead to a diffusion of the disease. But in many districts in Oudh, where cholera comes almost every year, the funeral feast is not held if the deceased had died of cholera. But the remarkable point is that the relatives are regarded as

unclean for the usual time and all other funeral customs, such as white-washing, &c., are carried out as usual. In some cases after the epidemic has come to an end, an image supposed to represent the deceased is made of corn, and burnt with the usual ceremonies, and at the usual interval after this the feast is held. In Balrampur the body is buried at the time. Afterwards it is dug up and burnt, and at the usual interval after the burning the feast is held. I have not been able to find any evidence that this disagreeable custom has ever caused a recrudescence of the disease, nor do I consider it likely that it should do so.⁽¹⁰⁾

In certain districts however the custom has arisen of regarding the bodies of those dead of cholera of leprosy, or of snake-bite, merely as unclean things to be got rid of with as little trouble as possible. Hence they are often thrown into rivers without even an attempt at burning. This is the one thing in which I consider that interference with native customs is advisable. In the case of smaller rivers into which cholera corpses are thrown, it is probable that their water might thus become capable of producing the disease. In the case of larger rivers, whose waters consist in great part of melted snow, it is less likely that the custom could do harm in this way. But it is objectionable on the ground of it becoming a public

(10) Surgeon-Captain Clark, I. M. S., tells me that in the Kangra Valley the natives hold no funeral feasts if the deceased has suffered from cholera or typhus.

nuisance if it is extensively indulged in. The custom has already been restricted to a great extent and I hope we shall see the end of it in the not distant future.

(i) *The relatives of the patient.* Should they be turned out of their house? In answering this question it must be remembered that there are two risks to deal with: firstly, the risk to the relatives themselves, and secondly, the risk to others. So far as the risk to themselves is concerned, I am of opinion that the above described sanitary measures, which I regard as essential, can be far better carried out if the relatives are left in the house, or at all events only so far disturbed as may be necessary for cleaning the floor, &c. If the relatives apprehend that the *sahibs* are going to burn their clothes, put medicines into their cooking vessels, and make bad smells with burning sulphur, besides turning them out of the house, is it not probable that on the arrival of the officials many objects will already be concealed in the houses of neighbours or in whatever house they are going to live in on being turned out? Hence I consider that the sanitary measure of evacuating the house, considering the trouble that it is to the persons concerned, has more than counterbalancing disadvantages, and should not as a rule be attempted. Furthermore if the order is given that a house is to be evacuated, it is very likely to be disregarded. I once went into a house that I imagined had been evacuated in accordance with the orders that had

been given. I was looking for cholera microbes. I went into the *zenana* and found it full of women, who appeared to be quite at home and showed no trace of having been disturbed by anything more than my entry.

The possible risk to others stands on a slightly different footing. Enquiries should be made as to the occupations of the relatives. If it is found that any of them are *bhistis*, cooks, milkmen, *musalchis*, *khitmitgars*, or engaged in any other occupation leading to contact with other people's food, then I think they should be offered the alternative of being relieved of their occupations, or living for a few days in grass huts or other prepared buildings, where their health and surroundings can be better supervised than would be the case in their present home. It would not be advisable to apply this measure to any others than those actually engaged in such occupations. In some cases the Medical Officer concerned may think it advisable to dismiss such persons from their duties entirely. But this might easily lead to concealment of the truth. The relative of a patient might have no difficulty in bringing forward evidence that he was engaged in pulling a *punkah* during the day, and he would have equally no difficulty in concealing the fact that during the evenings he was engaged in a bar dispensing aerated drinks to soldiers.

(8) *If a case of cholera occurs in a European house in Cantonments, what should be done? The*

above described precautions can be carried out with a far better chance of success. Enquiries may be made as to the food eaten by the patient during the previous three days, as to the water he may have drunk and as to the water that may have come into contact with his food, supposing he has been staying in the locality. The indicated sources of water should be at once disinfected. The sweeper should be instructed to use disinfectants, both for his hands, for the dejecta, and for the *gurra* of water that he keeps for washing out the utensils from the *gussul-khana*. Fortunately the sweeper is as a rule not allowed by other natives to go near a well, and there is thus but little chance of his infecting the water-supply. Englishmen, who have been any time in India, usually adopt caste prejudices to the extent that they do not allow their sweeper to touch the water in their baths, washhand basins, or in the glass they use for washing their teeth. In cholera times more care should be taken that this rule is observed. Clothes, table-napkins, &c., used by the patient should be disinfected by boiling. Soiled mattresses, &c., that are too large to be conveniently boiled, may be burnt, if of little value, otherwise they may be sprinkled with carbolic powder and well dried. No one should be allowed to eat or drink in the same room as the patient, and attendants should be obliged to disinfect their hands before eating. Only boiled water should be allowed to be drunk in the house or barrack. A small quantity of

sulphuric acid should be added to the water in which the *musalchi* washes the plates and dishes. If acid is used neither soda nor *sujji* should be placed in the water, as these substances neutralise the acid. Care should be taken that the *jharans* or dish-cloths are well dried every day. This can conveniently be done in the hot case. If the aroma of the *jharans* is found to flavour the plates and dishes placed in the same hot case, this is a proof that the *jharans* are too dirty to be used. The *musalchi's* mop should be cremated. He will circumvent this unless a pair of forceps provided with a sliding ring are provided for him, with which he can hold the *jharan* with which he scrubs the plates. Such a pair of forceps can easily be made by a *mistri* for a few annas.

The floor or the furniture soiled by the patient may be disinfected with sublimate solution, or copper sulphate, or carbolic acid. Any part of the walls that he has soiled may be similarly disinfected or whitewashed. But I see no reason for fumigating the room as a means of ridding it from the cholera microbe. The custom of doing so is a relic of the old idea that cholera is a miasm, and the observed fact that the miasm was unaffected by this process was one of the things that made cholera so mysterious to our predecessors. No microbe gets into the air from liquids containing it, unless they are dried up, when it may be carried about as dust. For instance, Schimmelbusch states that the air of sewers is freer of microbes than that of streets and

gardens. If the contents of sewers were dry, no doubt their microbes would pass into the air readily enough, but so long as the sewage is wet its microbes find no means of so doing. The cholera microbe cannot get into the air in this way, because it is so readily destroyed by drying. With other microbes, such as that of influenza, this may happen, and with such a disease fumigation may be advisable. That the cholera microbe does not get into the air is proved, so far as a negative result can prove it, by experiments recently carried out by Haffkine and Simpson.⁽¹¹⁾ The air was tested in dirty and cholera stricken huts in a Calcutta *bustee*, where one might well expect the microbe to get into the air if this ever happens. The air was drawn through some peptone solution for two hours by means of an aspirator. The peptone solution was afterwards incubated, but no trace of the cholera microbe developed. Flies, however, can carry the cholera microbe about with them, and if the room is fumigated they will be driven out and may carry the infection into neighbouring buildings. The danger from this eventuality is illustrated by the case described on page 31. Surely it would be more rational to attempt to kill the flies by means of fly-papers, which, as they contain arsenic, may fairly be expected to disinfect the flies they kill. Unfortunately fly-papers appear

(11) Haffkine and Simpson : " A Contribution to the Etiology of Cholera " (Transactions of the Indian Medical Congress, December, 1894, p. 28.)

to attract more flies than they destroy. Hence they should not be put into a dining-room or cook-house or near the patient, but only in verandahs or in the room vacated by the patient after he has been removed.

If the above precautions are attended to, it ought to be scarcely more necessary to evacuate a house or barrack, because a case of cholera has occurred there, than it would be for a case of enteric. It may be necessary to evacuate the actual room in order to clean and disinfect it. But I suspect that evacuating the Married Quarters, for example, is a process apt to be accompanied by much bustle and confusion, conditions that may well lead to evasion of necessary sanitary precautions. If the case of cholera that has occurred is fated to be followed by many others, then it is probable that the water-supply is to blame. The most essential precautions then will relate to the water-supply. But in the confusion that I presume will tend to accompany a move, who is to ensure that the *bhisti* will not carry with him some of the infected water in his *mussack*? Or, who will remember to disinfect or destroy the domestic filter in which the microbes are busily breeding at the moment? Or, who will have time to take care that the cook doesn't use some filthy tank or stagnant well to wash up his plates and dishes on his arrival in his new quarters? In the kitchen or scullery are usually some large *gurras* of water used for washing up the various plates and utensils.

In the confusion of a move who will think of disinfecting them before they are re-filled with water on arrival in their new position? If a move results in a complete change of the supplies of food and water, it may be the surest way of running out of the reach of the infection, but if, as sometimes happens, it merely means a change from one barrack to a neighbouring barrack, accompanied by a hard day's work for the inmates, and no alteration in their water-supply, then it appears to me to be a manœuvre of the most questionable utility. The existing custom on this point is merely a relic of the old doctrine that cholera is a disease of locality, and objectionable in that it tends to detract attention from other measures based on the new doctrine that cholera is a disease of the water in the locality. A move, however, not from one barrack to the next, but from one barrack into a cholera camp at a distance involving as it does a change in the supplies of food and water, is a measure on a different footing which will be discussed in the concluding paragraphs of this book.

Steam and hot air sterilisers are now made for disinfecting clothes and bedding. It would be an advantage if one of these could be attached to every large station hospital.

(9) *Other precautions.* The consumption of uncooked fruit and vegetables should be stopped, specially in places like Rangoon, where I believe

they are irrigated by the Chinese method, that is to say, by a mixture of human ordure and water.

Excess either in eating or drinking should be avoided. Warning should be given of the fallacy of the popular belief that indulgence in alcohol is any protection against infection. Conditions that predispose to chill, dyspepsia or diarrhoea should be avoided.

Depression of spirits is commonly supposed to predispose to cholera. In old times when cholera was supposed to be due to a miasm, one of the recognised ways of combating the disease was to provide amusements for soldiers during the prevalence of an epidemic. Why funeral parties, with their depressing concomitants of slow music, slow marching and solemn references to the uncertainty of life, were not discouraged to a greater extent than was the case, I do not understand. Now-a-days we know that the "uncertainty of life" is mostly due to drinking unboiled water and we consider that fear of the disease, provided it does not amount to panic, will be an advantage if it leads soldiers to listen to and act upon such counsels.

Milk and *dahi*, for the reasons above explained, are little likely to convey the infection unless the microbe is of exceptional virulence. The case described in Chapter III, however, shows that such an accident may occur. The simplest precaution that can be taken, would be to arrange that none but hot milk should ever be put on the table for use in tea or otherwise.

Care should be taken during a cholera epidemic that adulteration of beer with water should be put a stop to. I once found the cholera microbe in a specimen of beer. It is unlikely in the highest degree that this was derived from the brewery. Either the beer had been adulterated with water, or it had been put into a cask that had been washed with contaminated water. An accident of this nature is not likely to happen with bottled beer.

During the Hamburg cholera epidemic, when Berlin was threatened by the disease, one of the precautions taken was that the butter was boiled. It has been found that cholera microbes die in butter in five days. Such a source of infection is possible but not likely. In India butter is kept in water, which is a perfect zoological garden of microbes. I once found the enteric bacillus in such water.

Microbes are supposed not to be destroyed by freezing. But it has recently been stated that if suspended in pure water the cholera microbe is destroyed by this process. Only if it is in a suitable culture medium can it stand cold. It sometimes happens that water in India is a very suitable culture medium for cholera microbes, and hence I think that during a cholera epidemic it would be worth while to inspect the ice factory, though it is not a very probable source of the disease.

It is not very likely that bread should convey the infection unless the microbe is deposited by handling on the outside of the loaf. Surgeon-General Cleghorn

told me of a case in which the bread was made of good flour, and then taken to the bazaar to be baked. Here it was adulterated with dirty water and possibly bad flour, some of the good dough having been taken out and sold. The baking was not continued very long in order that the water might not be driven off by the heat, so that the loaf would keep up its weight. This bread tasted all right when fresh, but if kept for a night it became sour, owing to the development of an acetous fermentation. This without doubt was due to the presence of microbes contained within the loaf that had not been killed by the heat. I have examined a loaf of canteen bread and found microbes still alive in the central parts of the loaf. Here is a possible source of enteric infection, but it is less likely that it should happen with cholera, as this microbe, as already mentioned, is more easily destroyed by heat. The risk may be removed by eating toast instead of bread.

Personal contact is a possible source of infection. Infected localities should be put out of bounds for soldiers, owing to the risk that they may eat or drink while they are there. One should however be chary in calling in a breach of this rule as an explanation of isolated cases of cholera without very definite evidence.

An outbreak of cholera occurred some years ago in Agra, in which I am informed that all the cases were traced to water from a single *mussack*. Other *mussacks* were filled at the same well. But these other *mussacks* do not appear to have contained infected water. Some time later I arrived in Agra, and found that near the well from which the *bhisti* had been in

the habit of drawing water, was a small tank containing black putrid mud. In this tank I found the cholera microbe. I failed to find it in the well itself. In the hot weather *mussacks* are apt to break unless they are kept moist both inside and out. As a rule the *bhistis* sprinkle water over them for this purpose. Sometimes however they soak them in a tank which may contain stagnant water. Possibly in the above case the *bhisti*, in question, had soaked his *mussack* in the infected tank adjoining the well. Of course I have no proof that this actually happened, but the possibility of such an accident occurring indicates the necessity of disinfecting small tanks of putrid water so far as is possible. In cases in which it is considered necessary to disinfect *mussacks*, this may most conveniently be done by means of lime. It is well to remember that *bhistis* do not like others than themselves to touch their *dols* and *mussacks*.

(10) *The use of cholera camps.* The undoubted good that cholera camps have done in the past can only be ascribed to the change in the supply of water and to a less extent of the food that is involved in going into camp.

It is probable that it may be well in some cases to continue the practice. But it ought only to be necessary in cases in which the source of the infection is not eliminated either by the rules in force, or by the suggestions I have made. The example given in Chapter III shows how difficult it may be in some cases to work out the causation of an epidemic, and how impossible it is likely to be in many cases for the

Medical Officers to do so at the time, while they are busily at work attending to the patients and taking the necessary measures to deal with the outbreak. Although it is not likely that cholera is ever contracted except by way of eating and drinking, it is possible that the rules described in this book do not cover all the ways in which food and drink had become infected. However perfect a code of rules might be, it is always probable that the ingenuity of our Aryan brother would be equal to circumventing them if they happened to interfere with his profits or his habits.

APPENDIX I.

THE DISINFECTION OF WELLS.

THE evidence that I now have in my possession relating to more than 40 epidemics, leaves no room for doubt that the disinfection of wells is of great use during cholera outbreaks. I have therefore not hesitated to recommend it as a sanitary precaution. Whether the methods I have recommended are sufficiently strong to be useful against more severe epidemics of cholera than those that we have had to deal with during the last year, must be a matter for future experience. So far as my experience goes the disinfection of wells in villages has always resulted in a complete cessation of cholera if the antiseptics have been added by a European to all the wells in the place. The cessation has generally been partial if only some of the wells in the place have been treated. The disinfection has nearly always failed to have any effect on the epidemic if it has been left in the hands of native assistants. I have published an account of the experimental evidence on which the method is based in the *Indian Medical Gazette*, November, 1894, in a paper read before the Indian Medical Congress in December, 1894, and in my annual report as Chemical Examiner and Bacteriologist to the North-Western Provinces for 1894.

The methods I have hitherto employed are as follows :—

(1) Permanganate of potassium. This substance should be added in the proportion of about one ounce to an ordinary sized well. The quantity added should be sufficient to produce a faint purple colour in the water that lasts till the next day. The solid permanganate should be put into a bucket or *dol*, which should be lowered into the well, filled with water, drawn up and the water poured back. This should be repeated until no more undissolved permanganate is left at the bottom of the bucket. After half an hour some of the water should be drawn up and examined. If it still has a purple colour, probably enough has been used. If the colour has vanished more permanganate should be added. The dirtier the well the more permanganate will be found to be necessary. If the well is used for drinking purposes it is not advisable to add a large excess, as this makes the water unpalatable. This however is of little moment if arrangements can be made for pumping out the water until the colour has considerably decreased. If the smaller quantity is used the water is fit to drink on the following day. Closing the well beyond this time should be avoided.

(2) Quicklime. The quantity of this substance to be added can be readily calculated by means of the following simple formula that I owe to the kindness of Major Dunlop, R. A. :—

Multiply the diameter in feet by itself, and by the depth of water also in feet, and divide the product

by 10. The resulting figure is the number of pounds of lime that ought to be employed. For example, suppose a well is six feet in diameter and contains 10 feet depth of water. Then the diameter, namely six feet, multiplied by itself gives 36. This multiplied by the depth of water, namely 10 feet, gives 360. This divided by 10 is 36. Consequently 36 pounds of lime have to be added. The proportion of lime in the water will then be roughly two parts in a thousand.

This quantity is ample and need not be exceeded.

The lime must be fresh. That is to say, it ought to become hot when added to water. It should first be mixed with the water in an earthen vessel, then poured into the well and thoroughly agitated. This can best be done by means of a pair of bullocks and a *chursa*. By this means the water should be drawn up, and poured back into the well repeatedly. This process should be carried on for at least an hour. The water is then fit to drink, and the well should not be closed. Unfortunately lime kills frogs which are frequently present in wells. Hence it would be an advantage after adding the lime if a man could be lowered into the well to catch these creatures.

(3) Alum. This substance is sold in almost any bazar under the name of *phitkari*. It should be added to the water in the proportion of one-sixth the quantity recommended for lime. It should be put into a rather heavy box made of perforated zinc. This can be lowered into the well and agitated till all the alum

is dissolved. I have heard of two or three cases in which cholera in villages has ceased immediately on the addition of alum to the well water, but bacteriologically it has not given me such good results as have the other two substances recommended. The use of alum to clarify water is, I am told, universal in China. Nevertheless the country has suffered severely from cholera on several occasions.

APPENDIX II.

THE following is a translation of certain sections of the rules for dealing with cholera issued by the German Government in the year 1893. I have mentioned the titles only of certain sections that I have not translated. The official report issued by the Kaiserlichen Gesundheitsamt points out that probably it is owing to the strict observance of these rules that the cholera in 1893 did not assume an epidemic form in Germany, though the risks of importation were far greater than in the preceding year.

PRECAUTIONS AGAINST CHOLERA.

A. General precautions to be taken by the authorities.

(Not translated.)

B. Special precautions to be taken at places threatened or attacked by cholera.

In places in which a committee of public health does not yet exist, such a committee should immediately be appointed.

Even before the commencement of the epidemic, the condition of the locality is to be examined in reference to the points mentioned in paragraphs 11 to 14 of

the preceding section ; steps are to be taken to remove such defects as may be discovered, especial care being taken in the case of localities that in former years have been severely attacked by the disease.

As soon as suspicious cases of disease or death happen, suitable specimens for bacteriological examination are to be sent with all possible haste to the appointed laboratory, packed as directed in the regulations. It is desirable that this should be done by whatever medical man happens to attend the patient, without waiting for the arrival of the official doctor.

If cholera is diagnosed, the following procedure is to be carried out :—

(1) Those suffering from cholera are to be separated from all persons except those engaged in attending or nursing them. Patients whose surroundings do not permit of suitable nursing and attendance are—if the doctor thinks it necessary and not likely to harm the patient—to be taken to a hospital or other appointed building.

Suspicious cases are to be treated as cholera cases, until all cause for suspicion is removed.

Under some conditions it may be preferable to leave the patient in the house and to turn out those who are healthy. Such measures are advisable in the case of those houses that have on former occasions suffered from the cholera, or in which are unfavourable sanitary conditions, (overcrowding, uncleanness, &c.). For housing those who have been turned out, buildings

should be chosen on high open situations which in previous epidemics have remained free from the disease.

(2) It is specially important, on the appearance of the first cases, to investigate thoroughly and intelligently the possible sources of infection. The precautions taken should in the highest degree be directed against any sources of infection that may be discovered.

(3) The Committee of Public Health should by means of frequent visits keep themselves informed of the condition of health of the inhabitants of the different houses in the district, and of their sanitary condition (cleanliness of the houses in general, removal of refuse, of waste water, closets, &c.). They should supervise the remedying of defects, and the closing of suspicious wells.

(4) In houses where cholera cases happen, it is the business of the Committee of Public Health to set going and to supervise the carrying out of the necessary measures for disinfecting the refuse and surroundings of the patient or of the deceased.

(5) All persons who owing to their occupations are likely to come in contact with the patient, his dejecta, or his belongings (hospital attendants, disinfectors, washerwomen) are to be instructed in the directions for disinfection (see below) with special care.

(6) Requirements of vacant buildings, attendants, doctors, medicines, disinfectants, and means of transports, should be arranged for in good time. A mortuary should also be provided.

Addendum I.—Form for filling in details of cases.

Addendum II.—Form containing weekly returns of cases to be sent to the Kaiserlichen Gesundheitsamt, (the central health office in Berlin).

Addendum III.—Essential arrangements for railway traffic during cholera times.

(a) General.

(b) Directions for treatment of ordinary railway carriages.

(c) Directions for treatment of sleeping carriages.

(d) Directions for carrying out disinfection.

(e) Directions for railway officials in the event of cases suspicious of cholera occurring in railway trains.

Addendum IV.—Rules for sanitary supervision of river transport and traffic (not translated).

Addendum V.—Instructions for public water-works provided with sand-filters, for use in cholera times.

(1) The filtered water coming from each filter-bed must so long as the latter is working be examined bacteriologically once each day. Each filter-bed must therefore have arrangements permitting the taking of a water-sample immediately it issues from the filter.

(2) Filtered water containing more than 100 microbes in a cubic centimetre should not be allowed to pass into the clear water reservoir. The filter-bed should therefore be so arranged that such imperfectly purified water can be run to waste without any chance of its being mixed with that coming from other filter-beds.

Addendum VI.—Directions for carrying out disinfection against cholera.

I. As disinfectants the following are recommended :—

1. Lime Solution.

For preparation, one part of quicklime finely powdered is mixed with four parts of water in the following way :—

A little less than a quarter of the water to be used is placed in the vessel in which the mixture is to be made. The quicklime is then added. So soon as the quicklime has absorbed the water and fallen to powder, the rest of the water is to be added while stirring vigorously.

If this is not to be used immediately, it should be kept in a well closed vessel, and be shaken before use.

2. Chloride of lime.

This substance has only a satisfactory disinfectant action if it has been freshly prepared and has been kept in a well closed vessel. Its freshness can be judged by its peculiar odour which ought to be strongly marked.

It may be used either in the form of powder, or in solution. The latter is obtained by adding two parts of the chloride of lime to 100 parts of water. After settling the clear solution may be poured off from the sediment.

3. Solution of Potassium Soap (so called soft soap or black soap).

To prepare this, three parts of the soap are dissolved in 100 parts of boiling water.

4. Solution of carbolic acid.

(a) Carbolic soap solution.

Use the ordinary brown liquid commercial impure carbolic acid.

To prepare it, first make the above described soap solution. While it is hot, add to 20 parts of it, one part of the carbolic acid while stirring.

This solution keeps its properties for a long time, and acts more rapidly than the simple soap solution.

(b) Carbolic acid solution.

If only pure carbolic acid is to be had the addition of soap to the solution is unnecessary, as it will dissolve in pure water. It is more expensive and not more active than the commercial acid. (The proportion to employ is one part in 20 of water.)

5. Steam sterilising apparatus.

The best forms are those in which steam is used at a pressure above that of the atmosphere. The excess of pressure should be equal to one-tenth that of the atmosphere. The working of the apparatus should, if possible, be left in the hands of a skilled assistant.

6. Boiling in water for several hours, or boiling in salt and water, or in soda solution, may be relied on for disinfection.

The choice of disinfectants will depend on conditions. If No. 4 cannot be obtained, then Nos. 1 to 3 may be used. If these cannot be obtained, then either a weaker carbolic acid in larger quantities or some other recognised disinfectant must be employed.

DIRECTIONS FOR USING THE DISINFECTANTS.

1. The dejecta of the patient.

Vomit and dejecta should, as far as possible, be collected in vessels and well mixed with equal parts of lime solution. The mixture should stand for an hour before it can be regarded as harmless.

Chloride of lime may also be used for disinfection of fluid dejecta. At least two tablespoons full of the powder are to be added to each pint of the dejecta. The mixture may be regarded as harmless after 20 minutes.

Occasionally it may be necessary to disinfect the dejecta by boiling them for an hour in water. The vessels that contained the dejecta should also be boiled for this time. The disinfected dejecta may either be buried or poured down the closet.

Used washing water should be similarly disinfected, and so much of the lime solution should be added that the mixture gives a strong and lasting blue

colour to litmus paper. One hour after this reaction has been obtained, the water may be thrown away.

2. Hands and other parts of the body must be disinfected by thorough washing with chloride of lime solution, or with carbolic soap solution, every time they come in contact with infected objects, such as dejecta or soiled linen.

3. Bed linen, clothes, carpets, &c. must be put in a tub with soft soap solution, or carbolic soap solution, or with carbolic acid solution. The quantity of solution added should be enough to cover the objects after they have become impregnated with it.

The objects to be disinfected must stay in soft soap solution for at least 24 hours, in carbolic soap solution, or carbolic acid solution at least 12 hours, before they can be taken out, washed with water and further cleaned. The water thus used may be regarded as harmless.

Linen, &c., may also be disinfected by heating in steam sterilisers or by boiling. But even in these cases they should be first wetted with one of the above-mentioned disinfectant solutions, and either put into well closed vessels or wrapped in cloths that are wet with the disinfectant, in order to avoid the risk from handling. In any case the person who carries out the disinfection must purify his hands by the method indicated in the above paragraph No. 2.

4. Articles of clothing that cannot be washed must be disinfected in a steam steriliser.

5. Articles of leather are either to be treated as in the above paragraph, or they are to be simply rubbed with carbolic acid, carbolic soap, or chloride of lime solution. Furs are to be thoroughly wetted to the roots of the hairs with solutions Nos. 3 or 4. After they have been left thus wetted for 12 hours they may be washed and further cleaned. Fur trimmings on cloth should be taken off, before treatment.

Wood and metal portions of furniture, &c., are to be rubbed carefully and repeatedly with pieces of rag dipped in carbolic soap or carbolic acid solution. The floor of the room used by the patient is to be similarly treated. The rags should afterwards be burnt.

The floor may also be purified by means of lime solution, which should be left on it for two hours before being washed off.

6. The walls of the room inhabited by the patient should be wiped over with lime solution, or washed with solutions Nos. 3 or 4.

Carpets may be rubbed with bread crumbs. The resulting crumbs are to be burnt. After disinfection the rooms inhabited by the patient are to be left unused for 24 hours, if possible, and well aired. In winter they should be heated.

7. Soil, plaster, gutters, &c., on which cholera dejecta have fallen, and also gutters containing suspected refuse, are best disinfected by means of lime solution, which must be freely used.

8. So far as public closets need to be disinfected, it is advisable once each day to pour into each a quantity of lime solution proportional to the frequency with which they are used. In the case of earth closets, &c., the receptacle should be cleaned inside and out with lime solution.

The seats should be sterilised with either lime solution, or one of the other mentioned disinfectants.

9. In cases in which disinfection of objects like mattresses or feather beds cannot be properly carried out, either owing to the quantity of disinfectant that would be required, or owing to the want of a steam steriliser, they are not to be used for at least six days, but they should be kept in a warm dry position exposed, if possible, to sunlight, but protected from rain.

Straw mattresses may be disinfected with their contents in the steam steriliser. It is more convenient to treat the straw as in the next paragraph, and the covering as if it was dirty linen.

Bedsteads whose wooden portions are not held together by glue may be disinfected in the steam steriliser, or it may be scrubbed with solutions Nos. 3 or 4.

10. Objects of small value should be burnt or buried after lime solution has been poured over them.

Disinfection is to be carried out with the greatest strictness in places open to the public which seem to be endangered, or in places in which infection has taken place. Waste of disinfectants is strictly prohibited; unnecessary and inefficient disinfection wastes

money, raises the price of disinfectants, and leads the public to carelessness owing to a deceptive feeling of false security.

Cleanliness is better than bad disinfection.

11. Bilge water of boats engaged in public traffic should be disinfected with the above mentioned lime solution, which must be poured in wherever the position of the cargo allows it.

The freshly prepared lime solution should be poured into the space near the keel in several different positions, if necessary by means of a funnel, and well mixed with the bilge water by means of sticks. The quantity of lime solution added must be sufficient for the mixture to give a strong blue colour to litmus paper. This should be tested preferably at another position than that at which the lime solution was added, and the piece of litmus paper should be preserved from contact with the sides of the ship by means of a tube.

Wherever conditions of space permit it, so much lime solution should be added as to double the quantity of liquid present.

The mixture should not be pumped out till at least an hour has elapsed. Simple throwing of quicklime into the bilge space has no efficient antiseptic action.

Iron ships that have no bilge water do not as a rule need to have the bilge disinfected.

Addendum VII.—Information for the public about the nature of cholera and the precautions that ought to be observed.

1. The infectious matter of cholera is present in the dejecta of patients. It can from these dejecta get to other persons directly or by means of various objects and so produce infection.

Examples of such objects are linen, clothes, food, water, milk, and other drinks. By means of any of these, even when the infective matter is present in quite invisible quantities, the infection can be transmitted to other persons.

2. The spread of the disease to other places thus easily happens owing to those affected with cholera, or those recently recovered travelling to other places, in their attempt to avoid the danger. Hence it must be remembered that one may be already infected at the time of starting on the journey, and one can be better looked after and protected by observance of the following rules at one's own home than on the journey or in strange places.

3. Every one who wishes to prevent the infection arriving in their own houses should refuse to admit any person who has come from an infected district. Even on the appearance of only a few cases, persons coming from the place are to be regarded as possibly infected.

4. In cholera times one should live as regular a life as possible. Experience has taught that all disturbances of digestion favor the infection of cholera. One should therefore avoid everything that is likely to cause indigestion and excesses either in eating or drinking.

Specially should anything be avoided that tends to produce diarrhoea or irritates the stomach. If nevertheless diarrhoea begins then get medical assistance as soon as possible.

5. One should eat no food coming from a house where cholera is present.

Food by means of which the infection can be transmitted, such as fresh fruit and uncooked vegetables and milk, should in localities affected by cholera only be eaten when cooked, unless one is well assured that they are above suspicion.

Similar considerations apply to food coming from cholera affected localities. Especial care must be taken not to drink uncooked milk.

6. All water that may have become defiled by ordure, urine, waste water from the kitchen, or other dirty substances should be strictly avoided.

All water from wells of ordinary construction in which sufficient precautions are not taken against infection, is to be suspected. Similarly all water coming from tanks, water-courses and rivers that has not been efficiently filtered must be distrusted. Especially dangerous is water that has been in any way defiled with the dejecta of cholera patients. In reference to this the greatest care should be taken that washing up water does not get into wells, &c., or even come near them. The best protection against infection of well water is to use only iron tube wells that go to a good depth into the earth (Abyssinian wells).

7. If it is not possible to get water that is above suspicion, then it is advisable to use none but boiled water for drinking purposes.

8. What is here said of water applies not only to that which is drunk, but also to all water that comes into household use in any way whatever, for the infective material may get into the human body also by means of the water used to wash the cooking utensils, or in washing or preparing the food, or even in washing or bathing.

9. It is especially necessary to avoid the idea that the infection only comes through drinking water, and that simply drinking boiled water is a sufficient protection from the disease.

10. Every patient can become the starting point for a new departure of the outbreak. It is therefore advisable not to nurse him in the house but to send him to a hospital.

If this is not possible then avoid any unnecessary intercourse with the patient.

11. No one whose duty does not send him there should go to a house where cholera exists.

Similarly during cholera times avoid any place where there is likely to be a crowd (market places, public amusements).

12. In places where cholera patients are present, one should neither eat or drink. Also in one's own interest one should not smoke.

13. Since the dejecta of cholera patients are especially dangerous, the clothes and linen that may be soiled with them should either be immediately burnt or disinfected according to the published directions.

14. One should take the greatest care that cholera dejecta do not get into the neighbourhood of wells, springs or water-courses used for drinking purposes.

15. Every object that comes in contact with the patient must be either destroyed by fire or disinfected with steam in the public steam steriliser, or kept for at least six days in a dry sunny airy place.

16. Those who come into contact with the patient or his bed or clothing, should disinfect their hands, and their clothing if it is soiled. This is especially necessary if any defilement with the dejecta of the patient has occurred.

Especial warning is given against touching any articles of food or drink with the hands before they have been disinfected ; or against putting to the mouth either articles of food or drink or cigars that have been in the patient's room and may have become defiled.

17. If a case of death occurs then the corpse is to be taken out of the house to a mortuary as soon as possible. If washing the body cannot take place in the mortuary, it should not be carried out.

The funeral procession should be as simple as possible. Mourners should not be allowed to enter the house in which death occurred. A funeral feast should not be held.

18. Articles of clothing or other articles belonging to the deceased should on no account be used or given away till they have been disinfected. Especially they must not be sent away to another place before they have been disinfected.

Those who receive such parcels from a cholera infected house are earnestly advised either to send them to a disinfection institution to be sterilised before opening them, or to disinfect them themselves.

The clothes of cholera patients may not be sent to the wash, until they have been disinfected.

19. Other modes of protection against cholera are not known besides those here mentioned ; and warning is given against the use in cholera times of those cholera medicines that are so regularly put forward and praised.

BY THE SAME AUTHOR.

THE BACTERIOLOGICAL TEST OF THE PURITY OF WATER.

(Written for the use of Municipal Engineers and others interested in providing water for drinking purposes.) Price 8 annas, may be obtained from the Manager, Star Press, Artillery Bazaar, Agra.

Haiza ke subbub aur iske roktam (The prevention and cause of cholera) 3rd Edition. A tract on sanitation, written for natives. Price per copy, in English, 4 annas, in Urdu and Hindi, 2 annas. In quantities of 100 or more is sold at a reduction of 15 per cent. May be obtained from the author, or from Dr. Wazir Singh, Thomason Hospital, Agra. Editions in Burmese, Tamil, Telegu, Malayalan, Canarese, Uriya and Bengali are being prepared by the Local Governments of the districts in which these languages are spoken.



