B U B O N I C P L A G U E

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I N D I A.

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- by -

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I N T R O D U C T I O N

For a period of three years I have been practising in India amongst the native population.

During that time I gained considerable experience in the symptoms, course and treatment of bubonic plague, having come into contact with patients suffering from all types of the disease.

In the present thesis I intend to give a brief account of this infectious disease in the forms in which it presented itself to me, and the methods of treatment which I adopted in dealing with it.

After discussing the Pathology and Etiology of Plague I shall point out the methods of diagnosis and facts relating to prognosis.

In describing the treatment I shall give an account of special cases which were under my care, and which were treated by me.

These will serve as illustrations of the conclusions drawn from practical experience, supplemented by the knowledge of experts on the subject.

E T I O L O G Y

It has been proved beyond doubt that the specific cause of plague is the pestis cocco-bacillus, which was discovered first by Kitasato and afterwards independently by Yersin in 1894.

The bacillus pestis is found in great numbers in the buboes, generally in pure culture. According to Manson, it is often in the later stages of the disease associated with the streptococcus and staphylococcus of suppuration. It is also present in great abundance in the spleen, intestines, lungs, kidneys, liver and other viscera, and in the blood, although in smaller numbers. It occurs also in the urine and faeces.

The plague bacterium obtained from the smearings or scrapings from the pulp of the buboes, or from any of the infiltrated lymphatic glands, is a short thick cocco-bacillus with rounded ends more or less ovoid in form. It measures from .8 mm. to 2 mm in length, and is usually from .4 mm. to 8 mm. in breadth. The bacillus varies considerably in size and shape, but the predominating form is the short oval rod.

It is easily stained by solutions of methyl blue, gentian violet, fuchsin or any of the ordinary basic dyes, but is not stained by Gram's method unless a weakened spirit solution of 50% is used instead of alcohol for the decolorizing process. Bi-polar staining is generally

the predominating feature but it is by no means constant in every bacillus. The micro-organism of plague is distinctly aerobic. It grows easily on ordinary culture media, such as gelatine, agar agar, broth, blood serum, and glycerin agar. In isolating the bacillus for diagnostic purposes from the living or the dead body, the temperature at which the culture medium is maintained is important.

Blood heat is not favourable to the growth of the plague bacillus, and if there are other bacilli present such as the bacillus coli communis, streptococcus pyogenes or the pneumococcus, these will grow while the plague bacillus will be inhibited. The bacillus does not form spores. If the bacillus is isolated from a plague case and pure cultures grown on ordinary nutrient media, the disease can be produced in some of the lower animals which are susceptible by inoculation, and from the tissues of these animals the microbe can be again recovered in pure cultures.

Added to this experimental evidence is the accidental production of the disease in man in the laboratory by inoculation with cultures of the plague microbe.

These cultures were in every case descendants through many generations of cultures of original microbes obtained from plague cases in India or elsewhere, and brought in culture tubes to the locality in which the outbreak occurred.

There never has been any doubt as to the plague in the laboratory being caused from any other source than the cultures, and the cases have occurred when no plague existed in Europe.

Vitality and virulence of the plague bacillus.

As a result of experiments the plague bacillus has been found to be very sensitive to drying combined with a high temperature.

When protected from these it retains its vitality for long periods. Its capacity to survive exposure to intense cold is much greater than its power to withstand the effects of intense heat, whether moist or dry. The microbes are killed at once when exposed to a temperature of 100° moist heat. Dry heat requires a higher temperature, and a longer exposure of the bacillus to be destructive. The effect of the direct rays of the sun is rapidly injurious to the vitality of the plague bacillus.

Pure cultures kept in the dark and prevented from drying can live for months or even years. Exposure to light causes rapid sterilisation of plague cultures or other infected material. In dust the bacillus appears to die out rapidly. Dry heat at 100°C kills plague bacilli in one hour, at 160°C in one minute.

As regards resistance to chemical disinfectants, cultures of the plague bacillus are easily destroyed by chemical antiseptics.

Perchloride of mercury (1%) destroys the vitality

at once, 1% carbolic acid or 1% lysol in ten minutes.

Variation in virulence.

According to Manson the virulence of the bacillus of plague is susceptible of modification both by artificial means and in a natural way.

It is well known that the virulence and case mortality of a plague epidemic show a tendency to decrease, the early cases being the most frequently and rapidly fatal. Observations on rats have proved that under certain unknown natural conditions, the virus tends to acquire increased potency, whilst in other circumstances its virulence tends to diminish.

Yersin observed that in cultures a proportion of the colonies developed more rapidly than others; if inoculation is made from these more rapidly developed colonies, virulence is found to be diminished, if they are frequently repeated in the long run they cease to be fatal to guinea-pigs, although they may still prove fatal to field mice. In others it apparently not only retains its virulence but increases in intensity.

Dissemination of plague.

It has been pretty well established of late years that fleas play an important part in the dissemination of plague. Experiments done by Major Lamb and Captain

Liston have shewn that the common Indian rat-flea (pulex cheopis) can transmit plague from an infected rat to a healthy rat confined in close proximity, but protected in such a way as to prevent direct infection. In 55% of the experiments, healthy rats living in flea-proof cages contracted plague after receiving fleas collected from rats dying of septicaemic plague in different cages. By other experiments it was found that if fleas were excluded the closest contact of plague infected animals with healthy animals did not give rise to the disease among the latter. These and other experiments seem to definitely prove that under natural conditions the rat-flea is an important agent in the dissemination of plague. These insects act as carriers of the bacillus. From experiments described in detail in the Reports on Plague Investigation in India (1912) it has been shown that there is a very fair relationship between flea prevalence and the number of rats dying from plague.

The natives of India recognise the connection between rats and the onset of plague, and in the villages they invariably leave their houses during an epidemic and go to live in the jungle for a time.

When the rats die, they take it as a signal to vacate their houses.

The ancients were also aware of the connection between plague and rat, e.g. in the Bible the rat is mentioned in association with the plague which broke out

amongst the Philistines after they stole the ark of the Covenant.

The Greeks of Asia Minor worshipped a rat-killing Apollo who was reported to remove plague epidemics. A coin of Lucius Servius was struck at the time of a great epidemic. On it is the god of medicine, AEsculapius, with a dead rat at his feet, and at his side a naked human figure in an attitude of terror.

These facts are now made use of in the effort to stamp out the disease during an epidemic by the wholesale destruction of rats, as well as by the isolation of plague-stricken patients.

P A T H O L O G Y

After death the surface of the body frequently presents numerous ecchymotic spots or patches.

These vary in number and extent. The characteristic buboes are generally apparent.

There is engorgement and haemorrhage of nearly every organ of the body. Extensive haemorrhages are occasionally found in the peritoneum, mediastinum, trachea, bowel, pelvis of the kidney, ureter, bladder or in the pleural cavity. Hypostatic congestion of the lungs is usually present.

The heart muscle is pale, soft, and friable, and is in a condition of cloudy swelling or fatty degeneration. The right side is usually distended with dark red blood which is coagulated to form soft clots or is in a semi-fluid condition.

The blood itself has very little tendency to form soft clots and remains fluid. It is usually of a very dark colour. The veins and smaller blood-vessels are distended and show large and small haemorrhages. The lymphatic glands are inflamed. Those of the groin, of the armpit, and of the neck are particularly affected. There is also evidence of intense hyperaemia in and around these glands.

If death has taken place at a very early stage of

the disease, the swelling of the lymphatic glands may not be so evident. In these cases, as in the septicaemic and pneumonic cases in which the bubo is absent nearly all the lymphatics of the body are slightly enlarged, pink or dark red in colour. There is, in these cases, a more generalised enlargement of the lymphatic glands of the whole body instead of an intense and localised adenitis. The enlargement of the glands is due to hyperaemia, inflammation, exudation and haemorrhage.

This condition is peculiar to plague. No other infectious disease shows a similar multiple inflammation of the lymphatic glands together with haemorrhages, exudative infiltration into the periglandular tissue, and presence of characteristic bacilli.

The veins in the vicinity of the bubo, such as the femoral, axillary, and jugular, participate more or less in the disease. By the haemorrhages into the walls of the veins there is established a direct communication between the glands and the veins.

Apart from the condition of the lymphatic glands and the diffuse haemorrhage there is nothing distinctive in the morbid anatomy of plague.

According to Sir T. Fraser, the vascular changes and the tendency to haemorrhage closely resemble the results of the toxaemia set up by certain kinds of snake poison.

Sites of entrance of the Plague Bacillus into the human body.

1. The Skin.

A deadly effect has been produced by applying a living plague culture to a carefully shaved area of the skin of rodents, thus proving that the bacillus can invade the body through minute breaches of its surface.

This probably applies to man, although oftem no definite primary lesion can be detected. The disease has in many cases been contracted by direct inoculation in the course of autopsies on plague patients.

2. Mucous Membranes.

From the fact that buboes occur frequently under the chin and about the angle of the jaw, it is evident that the plague bacillus can penetrate through the mucous membrane of the nose, mouth or pharynx. The same applies to the conjunctiva, as proved by conjunctivates and a plague bubo following the accidental coughing of a patient with pneumonic plague into the eye of a nurse.

3. Respiratory Tract (except nose and mouth)

The bacillus gains entrance by means of the inspired air in cases of the pneumonic type. These cases are very infectious.

Seasonal relations of Plague.

There are certain seasonal relations of plague. In India the epidemics begin about October continuing through the Winter, reach their greatest intensity in March or April and subside in June, though there is never a complete cessation even during the summer months. From observations made in other countries, it has been concluded by some authorities that summer heat in hot climates and winter cold in temperate climates check plague. In India the mode of living of the people may have much to do with the question. During the hot weather, which lasts from April to October, the native population live and sleep practically out of doors; (except during the extreme heat of the day); in the winter they herd together in close unventilated houses, using blankets and clothing which may retain fleas or infection from a previous epidemic.

Recent investigations made during the last few years in India have brought to light some interesting facts bearing on this subject.

From carefully tabulated figures, it has been shown that in Madras and elsewhere there is a seasonal variation in the abundance of rat fleas.

This insect was most abundant in December and January, 5.2 per rat being the maximum, while only half as many were found in the hot dry weather in June and July, 2.2 per rat. In other places, though the minimum figure is the same,

2 or 3 per rat, the average number of fleas on each rat has been much higher, 19 fleas in Belgium, 13 in Lucknow, 18 in Cawnpore. As a result of experiments described in the Reports on Plague Investigation in India (1912) there is strong evidence that the seasonal variation in the prevalence of fleas, which has been shewn to be one of the conditions affecting the occurrence of epidemic plague is due to conditions which exert a direct influence on the flea and that among these factors are atmospheric humidity, and to a less extent temperature.

D I A G N O S I S

The incubation period is generally taken as from 3-5 days or at most 10 days. There is usually a prodromal stage which may only last a few hours. Often the onset is quite sudden, shewing itself by high fever, 102°, 104° or even 107° 2/5 and rapid pulse, from 90 to 120 or even more. The characteristic small and thread-like pulse is of great diagnostic value to those accustomed to plague cases.

Weakness and loss of power of articulation are also of value in the diagnosis, being almost constantly present.

The duration of the febrile stage is from 2-5 days, but sometimes it is much longer. The fall of temperature may be sudden or gradual, or a recurrence of high temperature may take place after 3 or 4 days.

In some instances the buboes are the first symptom to attract the attention of the patient by a sudden sharp pain. More usually they occur after the onset of fever and sometimes late in the disease.

At first the glands are hard and, in fatal or severe cases, they may retain this character to the last; in other cases, suppuration occurs. This is a late feature, and is generally regarded as a favourable symptom. Rapid softening or even disappearance of a bubo during the height of an attack is sometimes observed, and is a sign of the worst omen, being speedily followed by death. In suppurative

cases which recover, the process may be prolonged for days or even weeks, and may leave formidable scars.

The size of a bubo is that of an almond or a walnut generally, but it may attain the size of an egg or of a small orange.

The inguinal glands are the most frequently affected, then the axillary glands, the cervical, submaxillary. Other glands only occasionally affected.

Duration of an attack.

From 3-5 days is generally the duration, but cases in which suppuration occurs may go on for weeks. Dr. Simpson gives as his experience that death may occur within 1 or 2 days or less, but it may be later, from 3rd to 7th day. It usually occurs between 2nd and 6th day.

In the pneumonic form there is no primary bubo and there may be few or no prodromal symptoms. The facial expression is one of great anxiety and there is imperfect articulation as in the bubonic form. Pleuritic pain may be felt on 2nd, 3rd, 4th or 5th day. The prominent symptoms are cough and blood-stained expectoration.

The sputum contains bacilli in great numbers. Death occurs from failure of the heart.

This variety almost invariably fatal, and is highly contagious. Sometimes by accidental inoculation the bubonic form results, as in the case already referred to when a portion of sputum falling on the conjunctiva gave

rise to ordinary bubonic plague.

Septicaemic form.

This begins as in the other varieties with rigors, headache, vomiting, and high fever. The implication of the nervous system is marked. Extreme nervous prostration, drowsiness, restlessness, small and full pulse, tympanites, delirium, picking of the bed-clothes, stupor and coma follow. Death may occur on 1st, 2nd or 3rd day with collapse.

In fatality this comes near to the pneumonic form.

Difficulty in diagnosis is only present on the 1st day of illness if the patient is seen as early. In a country where plague is always more or less present, and especially during an epidemic, the sudden occurrence of high fever, a quick pulse, and the anxious countenance even without any tenderness or swelling of glands are suspicious symptoms. When adenitis is present in addition, there is little doubt as to the diagnosis.

In pneumonic plague there may be some doubt in the early stage, but the quick pulse and the rapid course of the disease leave no room for doubt after the 1st day. As a rule patients are first seen on the 2nd day when little doubt can exist as to the diagnosis. The discovery of the bacillus in the glands, sputum, or discharges is a certain proof, and in a country where plague

is not always more or less present the test should be resorted to.

A small quantity of the suspected material should be spread on a slide, fixed and stained with an aniline dye. If a cocco-bacillus is found with the characteristic bi-polar staining, it should be cultivated by Haffkine's method in broth on which clarified butter (ghee) or cocoa-nut oil is floated.

If the bacillus be that of plague, stalactite-like growths of bacilli will grow from the under surface of the oil. When disturbed the stalactite growths break off and fall in snow-like flakes to the bottom of the vessel. No other known bacillus behaves in this way.

CLINICAL FEATURES

Multiple buboes may also occur in regions in close proximity to the primary bubo or in distant regions. Petechiae of variable size and pustules may appear on the buboes or independently of them. This pustular form of plague was more common in some of the older epidemics.

Next to the presence of buboes, the most characteristic symptoms are those connected with the nervous system, e.g. great depression, severe headache, giddiness, staggering gait, and stammering speech. Restlessness and sleeplessness also are present. Delirium may be continuous or only present at night. It may be noisy or of a quiet character. Death is usually from heart failure, but it may be due to exhaustion, asphyxia or coma.

The action of the virus may be that of an hypnotic, in which case the patient lies in a condition of mental and physical inertia. In cases that recover, the cerebral and nervous disturbances do not generally cause any permanent injury.

In severe cases, the pulse soon shews signs of a tendency to heart failure produced by the paralysing effect of the plague toxins. This is shewn by the frequency of the pulse and the rapid fall in arterial tension.

At the beginning of the illness, the pulse may be full and somewhat frequent, but it soon becomes feeble,

rapid, intermittent, and dicrotic, and finally, in cases likely to be fatal, so thready that it is impossible to count.

Sometimes heart failure occurs suddenly without any signs of collapse.

The peculiar expression of the face, the characteristic appearance of the tongue which is at first furred with red tip and edges, the halting speech and the great prostration are characteristic symptoms of plague.

The tongue is at first moist, then it becomes dry, and sordes appear on the lips and teeth, the whitish coating turns to a brown or reddish-brown colour while the tip and edges remain red. The urine contains albumin and the abdomen swells. Respiration becomes more frequent, the pulse becomes dicrotic and thready, and pneumonic complications are apt to occur. The view of to-day is that the bubo is the primary local lesion, the toxin becoming absorbed from it and giving rise to the general symptoms. The older views were that the bubo is in most cases only a local manifestation of the disease already in the blood. The discovery of the plague bacillus in the blood in nearly 45% of cases of plague admitted into Bombay in recent years, would seem to indicate that the older views were more correct.

The fact of the bubo appearing several days later than the onset of the illness is also in favour of plague being primarily a general disease, the affection of the

glands with the eruption of the bubo or buboes being a local manifestation of the disease as much as the skin eruption in small-pox, scarlet-fever or measles.

VARIETIES OF PLAGUE

Cases of plague may be divided under 3 forms, viz: the Bubonic, Septicaemic and Pneumonic, according as the glands, the blood or the lungs are mainly affected.

Some authorities add a fourth variety, as Pestis minor. This may, however, be considered as a mild type of the ordinary bubonic form, as it often occurs during an epidemic. The difference of severity may be due to the infection being less acute, or to the greater resistance of the individual attacked.

PROGNOSIS

The mortality of natives in India is very high, it may be more than 50%.

More die at the onset of an epidemic than later on when the symptoms are not so severe.

Absence of severe symptoms and survival beyond the 6th day are grounds for encouragement.

The most unfavourable symptoms are haemorrhage in whatever form it may shew itself, and petechial eruptions. Profound affection of the nervous system is also an unfavourable sign, and so is abundance of bacilli in the blood. Suppuration of buboes is always a good omen.

Prognosis in a particular individual depends upon a number of circumstances, such as the race or age of the person attacked, the period of the epidemic, the variety of the plague, and the degree of reaction manifested by the patient. Children between 5 and 10 years of age have lowest mortality.

Pneumonic plague generally ends fatally. In septicaemic plague also the prognosis is very unfavourable.

In the bubonic type the situation of the bubo exercises an influence on the gravity of the illness. Axillary buboes have highest mortality, femoral and iliac the next, and cervical the least. (Simpson) This order is not borne out by experience, but as the femoral and iliac glands are more often affected, there is probably

a greater case mortality. Statistics are wanting to prove this point. Great caution should be taken in giving an opinion. As regards diagnosis there is no disease so deceptive.

A good pulse, not more than 120 or 130 in the acute stage, absence of acute cerebral disturbance, and a rapid development of the bubo are collectively favourable signs. So is absence of albumin from the urine and presence of chlorides, also constipation or a few loose motions without diarrhoea. Suppuration of buboes is favourable.

Unfavourable signs are, great frequency of pulse and respiration from beginning of illness, high temperature which continues or suddenly falls with collapse, or a secondary rise which is much higher than the first, continued insomnia, early and violent delirium, severe vomiting or continued diarrhoea, haemorrhage from various channels, dicrotic and almost uncountable pulse.

Discovery of plague bacilli in the blood in large numbers is always a sign of gravity.

T R E A T M E N T

Modern methods of treatment are concerned mainly with preventive measures.

These preventive measures may be divided into two divisions:

a. Those regarding the community and

b. Those regarding the individual.

Quarantine measures are taken by authorities on land and sea, 10 days being the minimum time demanded from ships coming from an infected port.

Preventive measures also include isolation of the sick, disinfection of house with fomites and excreta, destruction of rats, and great care on the part of attendants in nursing patients suffering from plague, especially as regards wounds on their hands.

As regards the individual the best available prophylactic is inoculation with Haffkine's prophylactic vaccine, which, if done carefully, affords more or less complete protection, or at any rate, it modifies the severity of an attack. This measure of preventing the disease is now extensively employed in India especially in the large towns, and with encouraging results. Superstition and ignorance on the part of the Indian population have to be overcome before it can be generally used.

Method of inoculation by Haffkine's plague prophylactic.

Great care has to be taken in securing complete sterilisation of the syringe and needle.

To fill the syringe, which must be previously boiled, the sealed bulb containing the prophylactic is broken, and the fluid drawn up into the syringe.

The arm or loin is generally chosen as the seat of inoculation.

The part being first rendered aseptic, the needle is plunged into a raised part of the skin, 2½ to 5 ccm. being rapidly injected. The part is swabbed again with carbolic acid. Before proceeding to inoculate the next person, the needle of the syringe must be made aseptic either by boiling or by rubbing it over with cotton-wool soaked in a solution of carbolic acid. The effect of the inoculation is not noticed for the first 3 or 4 hours, then a slight feverishness sets in. There is a feeling of tenderness at the seat of inoculation which becomes reddened, ~~sunken~~ swollen and painful. The malaise and general disturbance varies in different persons. In 2 or 3 days the fever disappears, but the pain at the seat of inoculation may last for several weeks.

No injurious result has been known to follow except in 1902 when a bottle got contaminated with tetanus bacilli with fatal results.

The action of the prophylactic does not last longer than six months at the most.

This method of obtaining immunity is called active immunisation.

Another method is by the inoculation of the blood-serum of animals which have undergone active immunisation. This is passive immunisation. This serum treatment has not met with any success.

During the epidemic of 1910 efforts were made to inoculate the inhabitants of infected areas in the United Provinces, but there was great resistance on the part of the people. The number of inoculations performed was 76,120 and among these 442 deaths took place, but facts and statistics are given shewing the advantage of inoculation both in procuring immunity from attack and in mitigating the severity of the disease.

Description of some cases of plague which I treated in their native dwellings in Cawnpore during an epidemic in 1911.

Case 1. Hindu woman aet 35 with history of illness of 3 days' duration.

When I first saw her, the symptoms of plague were pronounced, high temperature, quick pulse, anxious countenance and slight swelling of gland on right side of neck. Potassium Bromide was given in gr. XX for the restlessness, a mixture containing strychnine, digitalis, and ammonia was given every 4 hours, small quantities of milk with of brandy in it every 2 hours.

Cold sponging brought the temperature down a little, but it rose again at night remitting slightly the next morning and rising to 104°7 on the 4th night. During that night the patient was at her worst, becoming delirious. I watched by her the whole time giving stimulants, and milk with brandy regularly. The patient's condition improved slightly the next day, but for a week afterwards the temperature kept between 101° and 103°, when it gradually came down and the other symptoms subsided.

The glandular swelling in the neck was tender and painful all through the illness, but it did not suppurate, in contradiction to the usual course of severe bubonic plague with recovery. The only treatment of the glandular swelling was painting it with belladonna and glycerine.

Case 2. In contrast with this was the case of a Hindu man who died suddenly on the 6th day of illness although his symptoms were apparently gradually subsiding, the temperature being nearly normal. The cause of death was no doubt heart failure, the pulse being very weak a few hours before death.

The patient complained of tenderness in the groin but no swelling could be felt.

Prostration was extreme, and there was pain all down the left leg.

Stimulants were given but not so much as in the previous case as improvement was apparently taking place after the 3rd day. This case proved to me that the temperature is no guide to the seriousness of the case, or as regards improvement. The state of the pulse is the all-important factor.

Case 3. An Indian man aet 35, who on 1st day of illness had a temperature of 104°, quick pulse, flushed face, coated tongue and constipation.

A purgative was given and quinine as there was some doubt as to the diagnosis.

The following day there was tenderness in the groin and a slight swelling, so there was no longer any doubt as to the diagnosis.

The symptoms were treated as they arose, cold sponging for the high temperature. Bromide was given for sleeplessness,

and stimulants to keep up the strength. On the 3rd morning the temperature was nearly normal, the pulse 80 and of fair strength. Gradually the patient recovered his strength and in about 10 days he was up and about again.

Case 4. A Hindu woman aet about 30, seen 8 days after onset of symptoms. The only history elicited was that she had had fever for some days. When seen by me there was no temperature or any other symptom beyond a large fluctuating swelling, the size of a hen's egg in the groin. The swelling was incised under chloroform and a large quantity of pus was evacuated. The discharge persisted for some 8 days afterwards, after which the patient made a good recovery.

Case 5. Was under my care for 6 days at the end of which time the symptoms were gradually subsiding and I left the man in the charge of a native doctor who was qualified.

The patient died on 10th day apparently from exhaustion, having refused to take the medicine containing stimulants after I left, and probably not having sufficient nourishment to keep up his strength just when it was most necessary.

Case 6. A Hindu woman who was critically ill for 8 days, then gradually recovered.

The symptoms were treated as they arose as in the other cases. The woman lay all the time in a small dark hut with no window and only a small entrance which necessitated

stooping to enter the hut, and amidst most insanitary surroundings, but she took the medicine and nourishment regularly, and her strength kept up in spite of a temperature of 103°-104°7 for more than a week. There was no bubo nor were there any lung symptoms; consequently I regard this case as one of septicaemic type.

Other cases, mostly of the pneumonic type, were fatal on the 3rd or 4th day, a few hours or a day or two at most after medical advice was sought.

The deductions to be drawn from these cases and from many others too numerous to be detailed at length may be summed up as follows:-

1. Keeping up the strength of the patient by stimulants and nourishment are the great essentials. Had careful nursing been available for the cases which succumbed, I am persuaded that the results would have been different.

2. The temperature is not to be depended upon as regards prognosis.

3. The pulse must be carefully watched.

4. Prognosis is generally very uncertain, cases apparently mild often end fatally.

5. The patient should not be allowed to sit up at all for at least 3 days after the temperature is normal in an ordinary case of bubonic plague. In severe cases and in the pneumonic form a longer time should elapse. In fatal cases there was often a history of the patient getting up or sitting up when the acute symptoms had passed off.

6. Antiseptics, as carbolic acid, salicylic acid, when tried produced no good results.

7. Early surgical interference in the local treatment of buboes is fruitless.

As regards treatment, inoculation, besides being a prophylactic measure, also mitigates the symptoms when used at the beginning of the illness. This was shewn in a patient who was inoculated at the onset of symptoms, the disease running a mild course afterwards.

In all cases of plague, stimulants, especially brandy, are valuable remedies. They serve to stave off the fatal attacks of syncope which occur with startling suddenness.

Brandy, no doubt, relieves the action of the heart, and the heart's efficiency is increased as a result of the dilatation of the superficial blood-vessels which follows the use of alcohol, through its influence on the vaso-motor nerves (James Macdonald, B.M.J. 1909). According to the same authority, alcohol does not stimulate the brain and nervous system, having in reality a depressant effect, and this sedative action is of value when there is delirium. Just as in Pneumonia which is admitted to be an acute infection by a germ, the remedial treatment is symptomatic, with administration of alcohol in severe cases, so in cases of plague it has been my rule to employ free stimulation with alcohol; it is certainly a valuable and necessary aid to other stimulants, such as digitalis and strychnine, pending the discovery of a specific remedy, such as quinine is for malaria.

SUMMARY AND CONCLUSIONS

As regards the occurrence of plague in India each year the area of its activity widens, each recurring epidemic seizes on new districts besides maintaining its hold on the old.

The mortality is nothing less than one of the most disastrous calamities for India.

At the end of 8 years, the annual mortality from plague in India has risen from less than 30,000 to little less than a million per annum in 1903. From the years 1901-1910 the total mortality was 6,473,704.

An important fact which is brought to notice by the examination of tabular statements of deaths in India is the immunity of Europeans in contrast with the susceptibility of Indians, even allowing for the comparative smaller number of Europeans in India.

Attention to cleanliness and hygiene are, no doubt, preventive causes, and of late years inoculation is resorted to by those Europeans who come into contact with plague, added to which there is the stronger constitution and absence of privation of the European.

On the other hand, insanitary conditions, although they provide a suitable nursing ground for the development or the spread of the specific agent of plague, and cause the population to become susceptible to the disease, do not appear to be the only factors necessary to the

production of an epidemic. Other influences and conditions as seasonal and meteorological influences which are still subjects of speculation, rather than of knowledge, must come into play before the plague germ can fructify to any great extent even in the presence of an insanitary soil.

The following facts are now established regarding plague:

1. Plague is due to a bacillus.
2. There is a bubonic, septicaemic, pneumonic and pustular form.
3. The Pneumonic form is very infective.
4. There is a connection between rat plague and human plague.
5. The disease both in human beings and in rats is seasonal.
6. Certain animals besides rats take plague.
7. Haffkine's prophylactic subcutaneously injected with a syringe has considerable protective effect.
8. There is no curative treatment that is effective against virulent plague.

Facts which have a bearing upon the hygienic treatment of plague are the following:

1. It has been shewn that the direct rays of the sun, as well as exposure to light, are injurious to the vitality of the plague bacillus. Usually an hour's exposure is sufficient but if the bacteria are protected by a covering or by the interstices of woollen fabrics longer exposure is necessary.

2. Experiments indicate that a deficiency in the amount of oxygen is favourable to the vitality of the bacillus.

3. Plague epidemics occur at particular seasons of the year. Connected with seasonal influences is also the peculiar fact that on the decline of an epidemic infected articles and houses in the infected locality lose their power of infection for the time being, until the favourable season comes round again. This regularity of the seasonal periodicity of plague in an affected locality may be explained by the seasonal breeding of rats.

4. Variations in temperature have a marked effect on the number of eggs laid by a flea, fewer eggs being laid at extremes of heat and cold.
The average life of the flea is considerably longer in a low temperature than in a high one.

5. Variation in virulence of the bacillus. This tendency to mutability as regards virulence on the part of the plague bacillus needs investigating more fully before practical use can be made of the fact. It suggests a possible explanation of the degree in severity in the attacks on different patients which cannot be solely, if at all, due to the constitution and strength of the patient. Some of the worst and

most rapidly fatal cases I have seen have been those of strong, powerfully built men, whilst those who recovered were women and children of the same family.

As regards inoculation, its effect may be summed up as follows:-

1. Inoculation sensibly diminishes the incidence of plague attacks on the inoculated population, but the protection afforded is not absolute.

2. Inoculation diminishes the death-rate among the inoculated population. This is due not only to the fact that the rat attack is diminished, but also to the fact that the fatality of the attack is diminished.

3. Inoculation confers a protection which lasts for some considerable number of weeks, possibly for a number of months.

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