A CONTRIBUTION TO THE AETIOLOGY OF EPIDEMIC CEREBROSPINAL MENINGITIS.

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The following contribution to the aetiology of cerebrospinal meningitis is published with a view to calling attention to the possible part played by dust in the causation of this disease. The strong connection between dusty occupations and cases of cerebrospinal fever, as here detailed afford, it is believed, a *prima facie* presumption that dust may be one of the vehicles of the specific germ.

Cerebrospinal Fever in India.

Though no less an authority than Hirsch [1] has stated that the Southern distribution of cerebrospinal meningitis (or cerebrospinal fever, as the disease is more conveniently called in India) is limited by the 30th degree of N. latitude, yet for the past 15 or 20 years the disease has been well known in India, the greater part of which lies well below the 30th parallel of latitude. The disease has also recently been recognised in Khartoum [2], in the Ashanti field force [3], and in the West Indies [4], so that it is clear that its southern distribution can be limited by no such arbitrary line*.

In India the disease has chiefly been recognised among prisoners or similar collections of men, *e.g.* in the coolie emigration depots in

* Editorial Note. Hirsch (1886, *Handb. d. histor.-geogr. Pathologie* Bd. III., p. 396) wrote "die Krankheit ist somit *bis jetzt* wesentlich auf gemässigte und subtropische Breiten beschränkt geblieben." Until the date of the appearance of his work there existed no *trustworthy* record of the disease further South than 30° N. L. both in the Eastern and Western Hemispheres. G. H. F. N.

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Calcutta[3], where labourers are collected prior to embarkation for the West Indies. In view of the latter fact it is strange that (as far as I can find out) the disease has only recently been discovered in emigrant ships trading with the West Indies[4].

It is not however intended here to trace the history of the disease. So far as India is concerned I have done this in another place[5].

The fact that this disease has chiefly been recognised among soldiers in barracks, and among prisoners, has led to an assumption that this incidence is in some way connected with defects in the hygiene of their surroundings. This may or may not be the case in other outbreaks, but in the three outbreaks, here detailed, the cases occurred at a time when (apart from this disease) the general health of the prisoners was remarkably good, the annual death-rate being about 13 per mille. It is possible that it is the greater care and attention to the diagnosis of disease and its registration which accounts for the seeming greater prevalence of this affection in such institutions.

THE BHAGALPUR PRISON OUTBREAKS.

The three separate epidemics or outbreaks which are here studied took place in the Central Prison, Bhagalpur, Bengal, during the four years 1897—1900.

The 47 cases here recorded were met with in irregular succession during four years, but they may, I think, be naturally divided into three separate outbreaks: viz. the first, extending from 11 January, 1897, till 18 April, 1897; the second from 17 October, 1897, till 20 April, 1898; and the third from 22 August, 1899, till the end of July, 1900.

Before January, 1897, a few cases of cerebrospinal meningitis had been noticed in this Jail: one case in 1889, one in 1890, six in 1891, and one in 1892. There were certainly no cases in 1893—1896. There was a six months' interval between the first and second outbreak, and an interval of sixteen months between the second and third.

First outbreak. The details of the first outbreak may be here summarised. There were nine cases from January till April 1897. All the patients were male Hindu adults, their ages varying from 24 to 45 years. Most of them had been confined in jail for at least three months (only one case, the seventh, had been there less than three months, viz. 36 days). The cases occurred in the following order of time, one case in January, another in February, two in March, and five in April. All died except the last case, which recovered after an acute attack.

These nine cases had been employed on the following forms of jail labour; six of the nine were employed in the jail garden, outside the walls, in gardening or in the

brickfield; of the three inside cases two were cook's attendants, and one was employed in sweeping roads inside the walls. The importance of these facts will be elucidated further on. Of these nine cases four came from Ward No. XV., and one case from each of Wards Nos. V., X., XII., XIII., XIV. (Total 9.)

Second outbreak. In this outbreak there were 14 cases, all in male Hindus, whose ages varied from 16 to 60 years. The period in jail before attack varied from 35 days to two years, but was usually about nine months. The infection was not brought in by the 35-day case, as it occurred eighth on the list. If we can accept so long an incubation period as 42 days, it is possible to say that the infection in this outbreak was introduced from outside by the boy who was attacked first, on October 17th. The next case, however, was in a man six months in jail, who was attacked two days after the first case.

The monthly distribution of these cases was as follows: October two cases, December one, January two, February two, April seven. From the local meteorological records it was found that in this, as in the first outbreak, strong dusty breezes had prevailed for a few days before the date of each case. The forms of labour furnishing cases were as follows: outside garden or the brickfield, nine cases; inside, rice-husking and wheat-grinding three cases, one was a cook's attendant, and one was from the indoor forms of labour in the blanket factory. The seven April cases occurred in true epidemic form on four successive days. As to the wards which produced cases, No. XV. had one; No. XI. two; the Juvenile Ward one; No. XII. two; No. XIII. one; No. X. one; No. VI. two; No. IV. one; No. II. one; No. XVI. two. (Total 14.)

Third outbreak. 24 cases occurred in the third outbreak, all amongst males, of whom 23 were Hindus and one a Mahomedan. Their ages varied between 19 and 40 years (average 30 years). The period in jail before attack varied from two months to seven years. The first case had been three months in jail, and the second over four months. The monthly distribution of the cases was as follows: August one, September one, October one, December one, March three, April thirteen, May two, July two. As in previous outbreaks the meteorological records show that strong winds had prevailed on or before the date of each attack. Cases came from gangs engaged on the following forms of labour: (*a*) gangs working in the garden or outside the jail walls, five; (*b*) wheat-grinding, four; (*c*) rice-husking, nine; (*d*) road-sweeping, three; (*e*) cooking, one; (*f*) convict messenger, one; (*g*) factory, a weaver. The cases in this outbreak came to hospital from a large number of wards, as follows: from No. III. one, from No. IV. three, No. IX. three, No. X. four, No. XI. one, No. XII. four, No. XIII. one, No. XIV. two, No. XV. five. In the third outbreak seven cases recovered and 17 died. (Total 24.)

Fatality. Of the 47 cases in the three outbreaks only fifteen recovered, a fatality of 68 %. This is practically the same fatality as in the recent outbreak in Boston, Mass., where there were 111 cases with a mortality of 68½ %. Rollet (1844) reported a rate of only 28 % amongst his cases at Nancy, but the fatality has reached 75 % in other epidemics (Bayonne, Aigues-Mortes). Hirsch states the fatality varies between 20 and 75 %[6].

Monthly Incidence of Cases. It is usually stated that this disease is chiefly met with in the spring and winter, this too has been our experience here, but most cases have occurred in the spring, as follows: January 3, February 3, March 5, April 25, May 2, June none, July 2, August 1, September 1, October 3, November none, December 2. In the following table the cases are grouped by seasons:

	Cases
Spring (March, April, May)	32
Summer (June, July, August)	3
Autumn (Sept., Oct., Nov.)	4
Winter (Dec., Jan., Feb.)	8
Total	47

In all three outbreaks most cases occurred in April, the month *par excellence* of hot and dusty wind-storms.

The Interval between Cases. In all recorded outbreaks the length of the interval between the successive cases has been very irregular. This has also been our experience, as the following figures show: In the *first outbreak* the first case occurred on January 11, 1897, and was followed by others at the following intervals: 24 days, 44 days, 9 days, 12 days, 4 days, 2 days (two cases), 2 days. In the *second outbreak* the second case followed the first after two days, then others with the following number of days between each: 48 days, 26 days, 22 days, 21 days, 13 days, 48 days (three cases), then another case after one day, then one day later three more cases. In the *third outbreak* (after 16 months free of cases), the first case was followed by the second in 29 days, then came cases with the following intervals between them: 28 days, 73 days, 66 days, 22 days, 1 day, 1 day, 1 day, 8 days, 4 days, then five cases on five successive days, then one 9 days later, then another after 22 days, then one after 49 days more, then after 10 days one. In each outbreak there was a run of cases in the middle period, *e.g.* in the first there were seven cases in four weeks, in the second seven cases in four days, and in the third sixteen cases in five weeks.

Age. Of the 47 cases only 2 were under 20 years of age. There were 8 from 21 to 25 years, 16 from 26 to 30 years, 11 from 31 to 40 years, 10 over 40 years of age. The juvenile prisoners suffered less proportionately to their numbers in the jail. The youngest case was aged 16, and the oldest 60 years.

Duration of Illness in Fatal Cases. Of the 32 fatal cases 18 were of the fulminant type, dying in three days or less. Of these 1 died in

about two hours, 6 in under 24 hours, and 4 in very little over the 24 hours. Twelve cases may be classed as acute, lasting from 3 to 15 days, and only 2 as chronic, lasting three or four weeks.

Mode of Onset. The sudden onset which is so characteristic of this disease was constantly noted in these cases. In only a few did the illness commence quietly, or with any noticeable premonitory symptoms. In almost every instance the patient had been at work as usual up to the evening before, or even on the morning of the day of attack. In one case the patient had been four days in the segregation-ward, on account of mumps, before the cerebral symptoms appeared. In only one case was the patient in bad health before the attack. As usual the disease chiefly attacked strong men.

Incubation Period. No evidence was obtained which throws any light on the length of the incubation period of this disease. If we suppose the germ to enter by means of the nasal cavities it probably does not take long to reach the brain meninges. The experience of the outbreak at Omdurman in 1898—99 showed that in some cases the incubation may be very short: as in two cases there, men sent to attend on other cases developed the disease within 52 and 76 hours respectively[1].

Prognosis. The prognosis is usually bad, the rate of fatality being very high. Relapses were not uncommon, and in some cases there were short intervals of apparently complete cessation of all activity of the disease. Lulls and temporary improvements were also not uncommon. For a favourable prognosis we have come to look upon the following as

[1] Since the above was written the question of the incubation period of Cerebrospinal Fever has arisen in connection with the epidemic in 1900 in the Calcutta Emigration Depots (see *Indian Med. Gazette*, vol. xxxvi. p. 78). An examination of the Jail Hospital Records has discovered the following facts about 6 cases in the third outbreak referred to in this paper: Case 1. An old man was discharged from hospital to work on rice-cleaning, and was admitted to hospital for cerebrospinal fever on July 27, or 6 days after going to work on this dusty form of labour.—2. Another man previously at work on the oil mill had his labour changed to rice-cleaning, on August 17, and after 3 days was admitted for the same disease.—3. Another man who had worked before in the factory was sent to work in the grain storeroom, and 8 days after came to hospital with this disease (April 23rd).—4. Another man was admitted 9 days after he was put into the outside garden gang.—5. Another man, a weaver, had his work changed on March 31st to be a storeroom messenger, and was attacked within 3 days.—6. Another man after having been in hospital for some trivial disease was sent to rice-husking on April 3rd, and was admitted to hospital for cerebrospinal fever on April 10th.

These cases also confirm a strong impression that such cases are apt to be met with a few days after a storm of wind and dust. It would probably be safe to put the incubation period of this disease at from 2 to 7 days.

important: a cleaning tongue, the disappearance of Kernig's symptom, and most favourable of all, a prolonged and quiet sleep. As an early aid to diagnosis Kernig's symptom is invaluable.

Association with Pneumonia. In only three cases in this series was there any association with pneumonia. In one case lobar pneumonia of the right base appeared towards the end of an acute case, in another a patch of central pneumonia was found, in a third a condition, which is noted as "resembling commencing pneumonia" is recorded. There was no special prevalence of pneumonia during any of the outbreaks.

Skin-eruptions. The only form of skin-eruption or rash observed in any of these cases was herpes. This was nearly always present, on the face or other parts of the body. It appeared at no regular period of the attack, and had no special prognostic significance. No form of petechial rash was observed.

Bacteriology of the Disease. It is now generally recognised that the microorganism of this disease is the *Diplococcus intracellularis meningitidis* of Weichselbaum. Other forms of meningitis are due to various organisms, but this *Diplococcus* is admitted to be the cause of the epidemic meningitis, which is called in the Nomenclature of Diseases of the Royal College of Physicians, London, "Cerebrospinal Fever."

For a full account of the history and the characteristics of this organism the reader is referred to the masterly monograph by Drs Councilman, Mallory and Wright, of Harvard University[6]. So far as I can learn the first described finding of the *Diplococcus* in India was in a case reported by myself in 1898. In the following year, in one of the cases in the second outbreak mentioned above, I sent specimens of the morbid material from the brain to Major F. J. Drury, M.B., I.M.S. &c., Professor of Pathology, Medical College, Calcutta, who reported the finding of a *Diplococcus*[7] in them which strongly resembled the published accounts of the *Diplococcus* of Weichselbaum. More recently, in the case which died July 23rd, 1900, I also sent specimens to Captain Leonard Rogers, M.D., I.M.S., the then acting-Professor of Pathology at the Medical College, Calcutta, and he reported the finding of the same organism. Since then Dr Rogers has had an opportunity of examining five cases belonging to an epidemic of the disease at the emigration-depots in Calcutta, and found in all five the same organism[8].

This then may be considered to establish the identity of the disease

in India with that known in other countries, a conclusion to which the whole history and symptoms of the disease strongly pointed.

Dust as a Vehicle of the Specific Germ. We now come to the main object of this paper, which is to point out the strong evidence which connects cases of this disease with dust, a connection pointed out to me by Captain C. R. Stevens, F.R.C.S., I.M.S., in conjunction with the cases in the third outbreak detailed above.

Germano has shown that the *Diplococcus intracellularis* can "resist desiccation, and preserve its vitality to the end of even ninety days," (this statement is quoted on the authority of the Report of the Sanitary Commissioner with the Government of India for 1898, p. 119)[1]. The following facts therefore are of special interest in this connection. Dust, it is presumed, is only the vehicle for the specific germ, and the medium in which it can remain latent and potentially active, till some unknown favouring condition rouses it into activity (possibly warmth or overcrowding or both), or it may be that the dust only

[1] Editorial Note. The *Diplococcus intracellularis* Weichselbaum, judged from its behaviour *in cultures*, has been generally regarded as incapable of leading a saprophytic existence, and it as a rule rapidly becomes attenuated when cultivated. There are but few observations mentioned in the literature regarding its resistance to desiccation. Jaeger (1894) is quoted by Germano (1897, *Zeitschr. f. Hyg. u. Infektionskr.* xxvi. p. 288—291) as having found the *Diplococcus* in a handkerchief six weeks after its being used by a patient suffering from cerebrospinal fever. Germano (*loc. cit.*) obtained his cultures from Jaeger. He made a concentrated suspension in bouillon of fresh agar cultures of the *Diplococcus*, dried it in Petri dishes over H_2SO_4 within 24 hours, broke up the dry substance with a glass rod and subsequently made agar plates with the material at various intervals of time, having previously mixed it with dust obtained from a room, with sand, earth (humus), marl, or brick-dust. Some of the material was kept moist, some of it air-dry, some of it quite dry over H_2SO_4. The *Diplococci* in all samples survived 80—90 days; in certain experiments, especially those with room-dust, a decrease in the number of germs was noted. Germano concludes that the *Diplococcus* is one of the most resistant of the non-sporogenic bacteria, and that it may very well cause infection when floating in the air as dust. Germano says nothing about having tested the virulence of the *Diplococci* he subjected to desiccation, which is certainly to be regretted. Councilman, Mallory and Wright (1898, p. 78; see Dr Buchanan's reference No. 6) dried blood-serum cultures of the *Diplococcus* on paper (the kind of paper used is not stated) and kept the paper in Petri dishes. When kept at room-temperature and in the dark, the organisms, as tested by cultures, were alive after 24—60 hours' desiccation, but not after 72—96 hours. *Diplococci* dried on paper, and kept at 37·5° C. for 24 hours were dead. The difference in these results may be due to differences in the individual cultures used, the viability being known to vary greatly even in cultures derived from the same stock. Moreover Kamen (1898, *Centralbl. f. Bakteriol.* xxiv. p. 555) believes that *Diplococci* cultivated for several generations outside the body possess greater viability than those derived directly from man. G. H. F. N.

acts indirectly by injuring the air passages and diminishing resistance.

Before, however, going on to show how the cases in the above three outbreaks are connected with dust, it is necessary to say something of the industries carried on in this prison.

The average number of prisoners varies from 1700 to 1800, the accommodation being for 1804. The chief industry of the prison is the manufacture of blankets for the army, some 700 prisoners being daily employed, indoors, on the various processes of weaving and spinning. Others are employed as work-overseers, tailors, carpenters, in carpet-making, and other minor industries. This accounts for some 1100 or so of the total population. All these industries are carried on *indoors*. The remainder of the population (excluding those under trial, in hospital, and females) are employed, either outside the walls of the prison in farming, gardening and in the brickfield, &c., or inside in worksheds, in rice-husking, rice-cleaning, wheat- or maize-grinding, or as cooks or ration-storehouse attendants. Usually there is also a gang of old or weakly men employed as road-sweepers, and another gang is in charge of the latrines. These various employments afford work for the remaining six or seven hundred of the population.

One broad distinction may be drawn between the two classes of labour, the thousand or so men employed in the Manufacturing Department are for the most part of the day confined indoors, within the substantial Factory Buildings, and are but little exposed to dust, whereas the other 700, employed either outside the walls or on the various forms of grain-cleaning, are constantly and greatly exposed to dust, either that blown about by the wind, or that produced copiously in the processes of grain-husking, &c.

It has already been shown that cases of this disease occurred chiefly in the spring and dry weather months, especially in April, when dry, hot dust-storms are of daily occurrence, and blow steadily from 11 a.m. till 4 p.m. It is also a significant fact that out of the 47 cases here recorded no less than 44 came from what may be called "the dusty occupations," and only 3 from the indoor industries. It is clear therefore that the men employed on the dusty forms of labour were more exposed to the germ of the disease than the considerably larger body of men employed indoors.

The following table shows this in a graphic manner:

Table showing the influence of dusty and dust-free occupations upon the prevalence of cerebrospinal fever in Bhagalpur Central Jail.

Occupations with exposure to dust	Cases	Indoor occupations, without exposure to dust	Cases
Public works and roof-repairing gangs	5	Factory Weaver	2
Gardening gangs	8	Factory Storeroom	1
Brickfield gangs	4		
Road-sweepers	2		
Limekiln	2		
Road-making	3		
(Food-preparation gangs)			
Cooks' attendant	4		
Wheat-grinding	6		
Pulse-cleaning	2		
Rice-husking	7		
Rice-cleaning	1		
Total	44		3

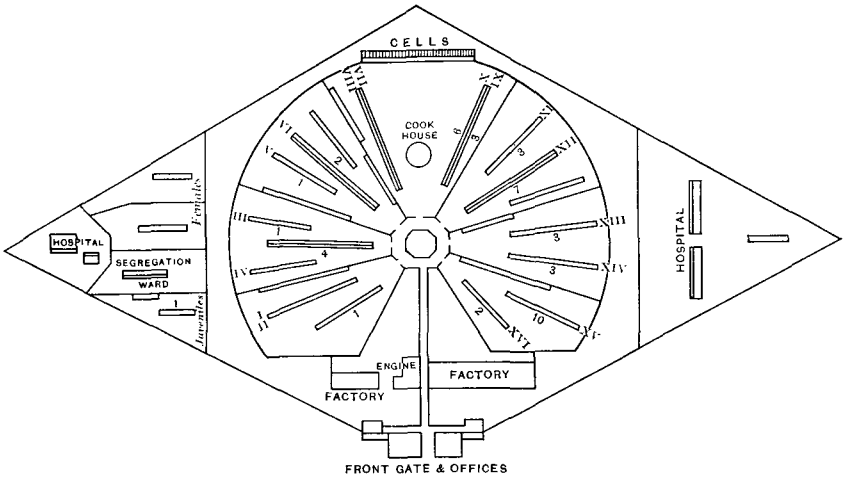
The influence of dust is also apparent from the following facts: the months from the middle of June till the middle of October make up the rainy season, when dust on the ground is at its minimum; now in these months there were in all only seven cases, and, what is important in view of the dust theory, is that every one of these seven cases came from forms of labour in which they were exposed to dust almost as much as they could be in the dry weather, viz., July, one case from rice-cleaning, and one from the wheat-grinding shed; August, one case, a cook's attendant; September, one case from the wheat-grinding shed; October, three cases, one each from the pulse-cleaning, wheat-grinding, and roof-repairing gangs.

I believe I am safe in claiming that the facts here presented form a strong case in favour of the presumption that dust is the vehicle of the germ of this disease. For anyone who knows India in the dry and hot weather it is not necessary to show how dust pervades everything and everybody in these seasons. It may also be stated that the men employed on the various forms of grain-cleaning emerge from their workshed as dusty as the proverbial miller.

The Source of the Infection. It is impossible to say whence the infection was first derived. When the first case occurred in these outbreaks there had not been a case inside the jail for four years, and

the disease was not recognised as existing among the outside population. The first man attacked had been one year in prison, so could not have brought the infection with him from outside; he was, however, employed in the garden just outside the jail walls. The second case did not follow till after three weeks, when a cook's attendant was attacked, who had been two months inside the jail, and never outside during that time.

In the second outbreak, six months after the last previous case, the first person attacked was a boy who had been six weeks in prison, and employed inside; the next case came two days later in the person of a man employed in repairing buildings outside the walls. In the third outbreak, which began sixteen months after the last previous case, the origin of the infection is equally unknown; the first case was in a cook, over three months in jail, the second case came a month later, then a third after another month, a fourth after two more months, then a run of 18 cases in six weeks.



PLAN OF CENTRAL JAIL, BHAGALPUR.

Roman Numbers I to XVI denote wards. Other Numbers denote cases of Cerebrospinal Fever.

It is possible of course that the disease *may* exist among the free population outside the jail. It has however never been recognised among them.

It has proved equally impossible to trace any connection between individual cases, they came at irregular intervals, from different forms

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of labour and from different wards. Exposure to dust seems the only link which connects them.

The Question of Ward Infection. Out of the twenty-two barracks or wards in the Jail, cases came in the three outbreaks from all except six. Some wards however furnished very few cases. The following table summarizes the occurrence of cases in the different wards.

Table showing occurrence of cases of cerebrospinal fever in Bhagalpur Central Jail in the different Wards during three outbreaks.

No. of Ward	Number of cases occurring in each Ward during three outbreaks			Totals in each Ward
	I	II	III	
II	—	1	—	1
III	—	—	1	1
IV	—	1	3	4
V	1	—	—	1
VI	—	2	—	2
VII	—	—	—	—
VIII	—	—	—	—
IX	—	—	3	3
X	1	1	4	6
XI	—	2	1	3
XII	1	2	4	7
XIII	1	1	1	3
XIV	1	—	2	3
XV	4	1	5	10
XVI	—	2	—	2
Juveniles' Ward	—	1	—	1
Totals	9	14	24	47

Number of Wards affected.

Outbreak	I	...	...	6 wards
,,	II	...	...	10 ,,
,,	III	...	...	9 ,,

The ward which produced most cases in the first outbreak was No. XV. with 4 cases, all from the same outside gangs and all within eighteen days; this points, at least, to infection from the same source.

In the third outbreak in ward No. XV. four cases occurred (two from rice husking and two from outside gangs) within four days, two cases came from No. XII. on two successive days, and two from No. IX. within three days. These facts point to a common source of infection rather than a spread of the disease from case to case. It may be added

that ward No. XV., in which the greatest number of cases have occurred in the three outbreaks, is one of the old-fashioned tile-roofed wards, in which (from considerations of safe custody) only prisoners with short sentences (total or remaining) are confined, and such prisoners are usually employed either in the garden, or on non-skilled forms of labour as grain-cleaning &c.

Contagion. It may be said at once that no evidence of direct contagion from case to case was obtained in any of the above outbreaks; in no case were any of those in attendance on the sick attacked, though it was possible to keep many of them under observation for many months after their attendance.

The distribution as given above of cases from the different wards is, I think, to be explained by the fact that the prisoners who occupied these wards at night were also associated during the day on the forms of labour which specially seem to expose the workers to the infection. It is of course not impossible that the infection in some cases was contained in the dust in the roofs of such old barracks as No. XV. or No. XIII. The roofs of these old-fashioned wards are made of bamboo mats and tiles and certainly contain a large quantity of accumulated dust. Such a thing is not possible in the majority of the barracks, which are fine lofty new buildings with cemented floors and flat cemented roofs. That the dust accumulated in old roofs has aroused suspicion in others as being a possible nidus for the germ is clear from the following quotation from the account of the outbreak at Omdurman[2]: "Apparent infection through dust which clings to old mats, walls, roofs, etc.....so that when these are removed they become a source of infection *en route* and in their new position."

Overcrowding. This factor is usually invoked in every outbreak of cerebrospinal fever, though, as a matter of fact, soldiers and prisoners are now better housed than members of the general public of the same social class. In this prison the capacity of each ward is calculated so as to give 36 sq. feet of superficial space per man, and in the new barracks this is increased to 40 sq. feet. The area of ventilation per man is no less than from 12 to 14 sq. feet, and in the warm weather, with the grated doors and windows open, the ventilation is ample and practically unlimited. Nevertheless though overcrowding is clearly recognised as a defect, and stringent rules are laid down for its avoidance, anyone acquainted with prison management must be aware that at certain times some degree of overcrowding is unavoidable. An examination of the "lock-up register," which daily records the numbers

confined in each ward, shows that on the majority of occasions when cases of cerebrospinal fever occurred in the wards, there was either very slight overcrowding, or at least the ward was full up to its registered capacity, in only 13 cases out of 47 was the ward less than full. We may therefore look upon overcrowding as having some influence, probably of a predisposing nature, on outbreaks of this disease. In no instance, however, was there any marked overcrowding, or for any prolonged period.

For the working out of the dust theory, in connection with the cases in the third outbreak, I am indebted to Captain C. R. Stevens, F.R.C.S., I.M.S., who was in charge of the cases, during my absence on other duty.

Conclusions.

1. The identity of what in India is called Cerebrospinal Fever with epidemic cerebrospinal meningitis is estabished, not only by the finding of the *Diplococcus intracellularis* in the Indian cases, but by the clinical and epidemiological aspects of the outbreaks, which exactly resemble outbreaks recorded in other countries.

2. A strong case appears to have been made out, in the present instance in the evidence recorded above, for connecting this disease with dust, either windborne, accumulated in roofs, etc., or produced in various processes of grain-cleaning.

3. In the Bhagalpur outbreaks no evidence was obtained pointing to direct contagion. In no instance were any of those in attendance on the sick attacked.

4. The disease was not associated with any prevalence of either pneumonia or influenza.

5. In no case could the disease be traced to any definite infection outside the Jail; the first cases in all three outbreaks were in persons who had been from six weeks to one year in jail.

6. Though a few wards produced a larger number of cases than others, there was no direct connection between the cases in these wards, nor between them and others, and often cases from the same ward came at long and irregular intervals.

7. The fact that 44 out of 47 cases came from forms of labour where there was great exposure to dust, and only 3 cases from the majority of the prisoners who were not so exposed, is difficult

of explanation unless we believe that dust either renders men more susceptible, or as is more probable, is the actual vehicle of the specific germ of the disease.

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