MEER).—The left elbow-joint had been freely opened, but it still contained some pus, and this was present also in the intermuscular planes outside the joint. The articular head of the radius possessed no cartilage cap and its end was rough and necrotic; there was also superficial necrosis of the humerus in the olecranon fossa, while the articular cartilage of the ulna was eroded and the subjacent bone showed commencing disease. There was a large abscess in connexion with the right hip-joint, which passed upwards and then forwards over Poupart's ligament into the extraperitoneal space in the iliac fossa, where it formed an encapsulated mass of the size of an orange, containing six ounces of thick, creamy, yellow pus. The neck of the femur showed necrosis and the articular cartilage was eroded. The bone at the bottom of the acetabulum was bare and necrotic, though there was no perforation. The serous cavities of the trunk were healthy. The intestines showed slight congestion of the lymphoid tissue. The liver and kidneys were pale, while the spleen was large and firm and of dark purple colour. The lower lobes of the lungs showed recent broncho-pneumonia with collapse. The heart valves were healthy but the myocardium was pale. The lymphatic glands both in the thorax and abdomen were large and reddened. The brain surface was flattened and covered with areas of purulent exudate, particularly along the course of the vessels. This condition was also very markedly present over the base of the brain, where there was excess of cerebro-spinal fluid. The choroid plexuses were infiltrated with pus. The grey matter of the cortex was softened and the lateral ventricles were distended with turbid fluid, while the third and fourth ventricles were little affected. No evidences of tuberculosis were found in the body.

Bacteriology.—Film preparations were made from the thick pus which was obtained from the elbow-joint. The microphages, which were by far the most common variety of oells in the pus, were full of minute rod-shaped bacilli which failed to retain Gram's stain. The pus was smeared on human blood agar and nasgar and incubated at 37° C. A good growth of minute, transparent colonies was obtained on the surface of both media. Each colony consisted of small Gram-negative bacilli. Cultivations which were made in liquid media remained sterile. Lumbar puncture was performed just before death and a few drops of turbid cerebro-spinal fluid were obtained. A pure culture of the influenza bacillus was grown from this fluid. A bacteriological examination was made after death with the following result. Hip-joint.—A pure culture of the influenza bacillus was obtained from the pus present in this articulation. Spleen.—The splenic juice was spread on tubes of blood agar and nasgar. A delicate growth of the influenza bacillus was obtained in each instance. Lung.—In the patches of broncho-pneumonia minute rod-shaped bacilli were found in some of the polymorphonuclear neutrophils and also diplococci. No cultivations, however, were made from the lung tissue.

Remarks.—The primary lesion appears to have been epiphysitis of the upper extremity of the radius, but there was no evidence of any sore or wound on the limbs such as is sometimes met with in cases of acute epiphysitis and osteomyelitis due to the staphylococcus aureus. There was no history obtainable of any influenzal affection in any other member of the family, and apart from the fact that the child was not thriving for one month before the onset of this disease her condition caused no anxiety. When first seen the case appeared obscure and examination by x rays failed to throw further light on the exact lesion. This was doubtless due to the absence of ossification in the epiphysis and the very small amount of destruction of bone at the time this examination was made. At the post-mortem examination, however, there was irregular pitting at the upper end of the radial shaft which would have been rendered evident had a second skiagram been taken. The disease proceeded with great rapidity both in the elbow joint and also as regards the systemic infection, and the sequence following the radial epiphysitis appears to have been first the elbow-joint and then the right hip-joint, followed very closely by the diffuse meningeal infection, and terminating in acute broncho-pneumonia. From all these situations, except the lungs, the influenza bacillus was obtained in pure culture. The splenic juice gave a similar result, while microscopic sections of the lung showed a bacillus morphologically identical present in the polymorpho-nuclear neutrophils. The pus found in the elbow and hip joints and over the brain surface possessed no distinctive characters and has been described above.

An investigation of the literature on the subject of influenzal arthritis has shown no similar instance of multiple suppurative arthritis due to the influenza bacillus, and in very few cases of what is termed "post-influenzal arthritis" have cultures been taken, and so far as we can ascertain these have yielded a negative result. Nor have we been able to find records of a case of pyæmia proved bacteriologically to be due to this bacillus.

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RECORD OF CHANGES OBSERVED IN THE BLOOD COUNT AND IN OPSONIC POWER OF A MAN UNDERGOING A PROLONGED FAST.

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THE following observations were made upon a fasting man, B., who for the purposes of such scientific observations fasted for fourteen days. The primary object of the fast was to afford Dr. E. P. Cathcart an opportunity of examining the urinary excretions. The results of his observations have already been communicated to the Physiological Society. The fast took place in my house and I availed myself of the opportunity to keep a record of the blood changes. Similar observations have been made by Luciani¹ on the fasting man Succi and by Senator and Müller² on Cetti and Breithaupt. Neither of these records, however, give any information about the relative changes which take place in the white corpuscles though they note the number of red corpuscles, the percentage of hæmoglobin, and the number of white cells. Differential counts were made by Okintschitz³ on rabbits deprived of food and water. Observations on the effect of starvation on resistance to infection have been published by Canalis and Morpurgo⁴ and Roger and Josué.⁵ An exhaustive index of the literature on inanition is given by Weber.⁶

Our experiment was divided into three periods. In the foreperiod the man was kept upon a constant diet and was in nitrogenous equilibrium. The fasting period lasted fourteen days. During it absolutely no food was taken, but a limited number of cigarettes was permitted which never exceeded two in the day. During the 24 hours one litre of ordinary tap water was consumed at the convenience of the subject. To obviate fraud the man was carefully watched day and night, and the analysis of the excretions show that the fast was genuine. At the close of the fasting period he was put upon a diet devised so as to contain no nitrogen. At the commencement of the experiment the man was in good health. His muscular development was excellent and he was not abnormally stout. When the fast began he weighed 10 stone 5½ pounds and at the close of the fasting period his weight was 9 stones 2 pounds 6½ ounces. The weighing took place at 9 o'clock in the evening when the patient was naked and just after the bladder had been emptied. During the fast the man remained in fair condition. There was a steady loss in weight and he became gradually less active. The mental condition did not appreciably suffer. He seemed to sleep soundly but complained that he dreamt of various kinds of food. As the fast proceeded he suffered very much from coldness and had difficulty in keeping himself warm.

The following table (Table I.) records the alterations which took place in the pulse, temperature, blood-pressure, and the blood condition during the fast. The temperature and blood-pressure were taken at the same hour in the evening, the latter being measured by Martin's modification of Riva Rocci's sphygmomanometer. The hæmoglobin was estimated by Gowers's hæmoglobinometer, and the corpuscles were counted with a Thoma Zeiss instrument. The films were stained with Leishman's and Jenner's stains.

The result of my observations may be briefly summarised as follows. The pulse slowed gradually as the fast proceeded. The man was aware of this fact from previous

¹ Das Hungern, 1890.

² Virchow's Archiv, Band cxxxii.

³ Archiv für Experimentelle Pathologie und Pharmakologie, Band xxxi.

⁴ Fortschritt der Medizin, 1890.

⁵ Comptes Rendus de la Société de Biologie, 1900.

⁶ Ergebnisse der Physiolog. Biochemie, 1902.

TABLE I.—Showing alterations in Pulse, Temperature, Blood pressure, and Blood Condition.

Day.	Pulse.	Tempera- ture.	B'ood pressure.	Hb.	Leucocytes.	Red cells.	Differential count 250-400 cells.					
							Tripartite.	Lympho- cyte.	Large mono- nuclear.	Eosino- phile.	Transit.	Baso- phile.
16/1/07	77	—	108	110	5,300	5,600,000	51*	30	11·6	1	6	—
17/1/07	70	—	108	—	—	—	62†	23	10	—	—	—
18/1/07	65	90°	96	110	—	—	75	11·7	7	2	4·5	—
19/1/07	68	—	98	110	—	7,200,000	61	23	9·5	2	3	1
20/1/07	65	97·6°	98	108	10,000	5,600,000	70	18	8	2	1	1
21/1/07	64	97·4°	92	108	—	6,400,000	63	22	12	2	2	—
22/1/07	66	97·2°	94	109	11,148	6,160,000	70	14	9	2	4	—
23/1/07	67	97·2°	88	108	14,000	—	77‡	9	7	3	2	1
24/1/07	65	97°	90	—	14,000	5,600,000	69	10	12	4	4	2
25/1/07	64	97·2°	88	—	—	—	60	26	6	5	2	1
26/1/07	62	97°	92	103	9,000	5,600,000	65	18	9	5	1	1
27/1/07	60	97°	88	98	—	5,000,000	60	25	10	5	—	—
29/1/07	58	97°	90	95	10,000	—	60	18	16	3	2	—
30/1/07	60	97·2°	88	96	9,000	5,200,000	56	26	13	4	1	—
31/1/07	59	97°	86	—	—	—	66	16	9	7	1	—
Before food.												
3/2/07	—	—	—	93	—	5,400,000	74	14	9	2	1	—
4/2/07	62	—	101	—	—	—	—	—	—	—	—	—
6/2/07	—	—	104	94	7,000	6,400,000	62	24	11	3	—	—
8/2/07	72	—	—	102	7,800	5,200,000	—	—	—	—	—	—

* Two hours after food. † Five hours after food. ‡ Count made from an unsatisfactory film.

fasts. The pulse became softer and weaker but remained regular in rhythm. The arterial pressure gradually sank so that at the end of the fast the fall amounted to almost 25 per cent. of the normal reading. On taking food this fall was soon made up, and by the end of the first week of feeding the pressure was practically normal again. Luciani, using a Von Basch instrument, found that the pressure on the radial artery of Succi fell from 22 to 12 cubic centimetres of mercury during a fast of 30 days. The blood changes are not very definite. For the first few days the hæmoglobin remained almost unaffected but towards the end of the first week it commenced to fall and thereafter fell steadily. This reduction persisted for several days after food was taken. The red corpuscles varied somewhat from day to day, but on the whole no striking effect was produced. The stained films showed practically no alteration in size, shape, or staining properties. In the last four days a few nucleated red corpuscles were observed. Neither Luciani nor Senator record having observed nucleated red corpuscles, but both agree that the hæmoglobin and number of the corpuscles vary from day to day. Senator accepts Luciani's suggestion that the number of the corpuscles probably does not alter much, but that the variation depends really upon the amount of fluid consumed. In Luciani's case the water consumption varied from day to day and he was able to show that the blood condition corresponded to the water consumption. In my patient the daily consumption of water remained constant, but the man was allowed to suit himself when he took the water except on certain days. The hæmoglobin did not correspond with the red blood count and probably indicates a true diminution. In the case of Succi, Luciani found that in the first week the white cells fell from 14,540 to 860, while the leucocytes became smaller in size. Thereafter the number rose again to 1500 and remained about this figure, while the cells regained their normal size and appearance. The Senator-Müller counts record a much less profound diminution. My enumeration, on the other hand, indicates a slight leucocytosis. There was certainly no manifest diminution in size of the individual cells. The differential counts are chiefly remarkable for the gradual increase in the percentage of eosinophyl cells. I cannot find any note about this point in human blood, but Okintschitz notes a similar increase in the case of starved rabbits. He found that the polymorpho-nuclear cells and small lymphocytes diminished while the eosinophyls and large mononuclear cells increased during absolute starvation with deprivation of water. The opsonic index of the blood for staphylococcus and bacillus typhosis was also investigated. Table II. shows the result.

TABLE II.

Date.	—	Staphylococcus.		Bacillus typhosus.	
		B.	F.J.C.	B.	F.J.C.
16/1/07 ...	Before fast ...	7·5	8·7	1·5	1·9
18/1/07 ...		5·0	6·0	—	—
21/1/07 ...		3·0	3·0	6·0	6·0
23/1/07 ...	Fast,	1·9	1·8	—	—
24/1/07 ...		2·8	1·6	2·0	1·8
28/1/07 ...		0·8	0·76	—	—
29/1/07 ...		0·6	0·7	0·6	0·6
3/2/07 ...	After fast ...	2·0	1·0	—	—
6/2/07 ...		11·0	12·0	—	—

The figures given represent the average number of organisms taken up by a polymorpho-nuclear cell. To obtain this average 30 cells were counted. A fresh emulsion was used each day and this explains the variation in the average number. As a rule the blood was drawn off in the afternoon and in each case was tested against my own serum drawn off at the same time and examined under similar conditions. For estimating the power of the sera my own washed corpuscles were used. The general result is that no alteration can be detected during the fasting period. The serum in my patient remained as active as my own. This is interesting as the man informed me that he had never suffered from a cold or other infection during his various fasts, though he always felt very chilly and had difficulty in keeping himself warm.

I have not been able to find much work bearing upon this point. Canalis and Morpurgo investigated the effect of starvation on pigeons and rats to determine whether they were thereby rendered more susceptible to anthrax. They found that pigeons lost their natural immunity to anthrax after fasting 6-7 days but regained it again on taking food. Hens previously rendered immune by injections of anthrax cultures did not lose this acquired immunity through starvation. Similarly rats remained immune despite starvation. On the other hand, untreated hens starved for from three to seven days succumbed more readily to inoculated anthrax. Roger and Josué tested the resistance of rabbits against the bacterian coli. They found that absolute starvation for 3-7 days followed by feeding gave an increased resisting power

compared with normal control animals. They hold that this depends upon the increased proliferation of the bone marrow which they have shown takes place during starvation.
Glasgow.

SOME CONSIDERATIONS ON EPIDEMIC CEREBRO-SPINAL FEVER.¹

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ALTHOUGH more or less extensive epidemics of cerebro-spinal fever have occurred in Europe for several hundred years, it was only recognised for the first time as a distinct disorder by Vieusseaux in Geneva in 1805. About the same time an epidemic occurred in the New England States and continued to prevail there for nearly a quarter of a century. Owing to the almost constant presence of a rash of a petechial character in those outbreaks in America the misnomer "spotted fever" was applied to it which ever since has been the source of much confusion not only to those members of the medical profession not familiar with it but also to the general public. It appeared in epidemic form in the South of France in 1837, spreading later to the North, numerous outbreaks occurring in that country until the year 1842. From 1846 to 1849 many fresh outbreaks occurred in France, when later it became widely diffused in Southern Italy. It made its appearance in Sweden and Germany in 1854, reaching its height in 1864. Dublin, Belfast, and Liverpool suffered from it in 1845 and again in 1866. Of late years it appears to have been widely diffused throughout the United States, where its area has extended from Canada to the Gulf of Mexico and from the Atlantic to the prairie States of Minnesota and Iowa. It prevailed during 1898-99 in a mild form, according to Osler, in 27 States of the Union and 1000 deaths occurred in New York city alone in the year ending February, 1905. Several outbreaks also occurred in Central Europe throughout 1905 and a number of doubtful cases in Northamptonshire early in the same year. The Local Government Boards of England and Scotland issued circulars to local authorities in September, 1905, calling attention to its existence in this country.

Glasgow epidemic.—The first authentic case occurred in Glasgow in March, 1906, and was removed to Belvidere Hospital. Numerous cases occurred thereafter and on account of its continued prevalence the corporation deemed it advisable to include it in the list of notifiable diseases. This took effect in Glasgow in August, 1906. From March to December, 1906, 205 cases came under observation by the health department here. Numerous cases occurred in Belfast and the disease was prevalent there in the spring of 1907. Early in the year I expressed the opinion that the disease was much more widespread than was generally recognised—in other words, that it existed in other cities and in all probability was being mistaken for other diseases. Since then cases have occurred in many towns in Scotland and in several in England. In investigating previous epidemics one is struck by the irregularity of their distribution and their peculiar commencement and cessation. The outbreaks appear in all instances in disconnected places and no well-defined channels of spread can be made out. Epidemics are generally localised and their duration variable. The same may be said of the outbreaks which are affecting this country at present. In those particulars, therefore, it differs from any of the acute infectious diseases, as, for example, small-pox, in which a definite epidemic curve can be traced and a connexion established from case to case.

Race and sex.—There is no racial disposition and the sexes are equally affected. The Glasgow figures for 1906 are: Out of a total of 205 cases, 121 were males and 84 females.

Age distribution.—Of 1267 fatal cases investigated by Hirsch 71 per cent. were under 15 years of age, 26 per cent. were between 15 and 40 years, and 3 per cent. were over 40 years. Of 105 consecutive cases admitted to New York Hospital in 1905:—

9%	occurred at ages 1 year and under (youngest 4 months).	
38%	" " from 1 to 5 years	82% between 1 and 15 years.
23%	" " " 5 " 10 "	
21%	" " " 10 " 15 "	
6%	" " " 15 " 20 "	
3%	" " " 20 " 25 "	(oldest 25 years).

¹ A paper read before the Eastern Medical Society, Glasgow.

Of 205 cases which occurred in Glasgow in 1903:—

18%	were under 1 year (youngest 2 months).
12.2%	were between 1 and 2 years.
5%	" " 2 " 3 "
8%	" " 3 " 4 "
12%	" " 4 " 5 "
20%	" " 5 " 10 "
10%	" " 10 " 15 "
4%	" " 15 " 20 "
4%	" " 20 " 25 "
5%	" over 25 years (oldest 52 years).

Some epidemics have confined themselves to adults in early middle life, as, for example, the Italian epidemic 1840-45 and the Alabama epidemic. Other instances of this peculiarity are the epidemics in camps and garrisons. Under one year it is more common than is generally supposed, and I am of the opinion that deaths certified as acute gastritis, teething and convulsions, and probably also summer diarrhoea may have been in some instances due to this disease.

Immunity.—Several rare instances of a second attack have been noticed in previous epidemics, and relapses may occur after the patient has apparently made a good recovery. The micro-organism may thus be capable of remaining latent in the cerebro-spinal fluid for a variable length of time and then take on renewed activity and virulence. No secondary attacks have occurred amongst any of the Glasgow cases. Relapses have taken place in a few instances.

Communicability appears to be very little. Previous epidemics have been recorded where a large proportion of the occupants of a jail, camps, and barracks have been affected. Several cases also have occurred in the same house sickening at or about the same time but the contagion seldom seems to linger and infect other occupants except in rare instances. Further, members of a family sleeping in the same bed with a patient usually escape, and medical men, nurses, and those who attend the sick are rarely affected. Of 205 cases which occurred in Glasgow in 1906 and 109 in January, 1907, in only 14 instances did two cases occur in one household and in two instances three cases.

Channels of infection.—No definite statement can be made at present. It is suggested that because a similar micro-organism has been found in the nasal secretions of many of the patients and others who have been in contact with the sick that this is the probable means of ingress. It is thought by others that as occasionally a history of a "fall on the head" is furnished, the filaments of the olfactory nerve having been injured or separated from the surrounding mucous membrane just as those filaments enter the cribriform plate of the ethmoid, a means of ingress is thus furnished. Others also support the view that it may find its way either by the veins or lymphatics in that region or by way of the frontal sinus, the tonsils, or the bowel. Nothing definite, however, has been done towards substantiating any of those theories. It is true that agglutination tests more or less satisfactory have been done with the blood of a recognised case or immunised animal with diplococci obtained from the nose, but much further research is necessary to arrive at anything like a definite conclusion on the matter. Since reading this paper, however, the micro-organism has been recovered by post-nasal swabbing from a fair proportion of the throats of "contacts" and it is assumed that those "contacts" may act as "carriers" (like diphtheria carriers) of the disease. It is to be noted, however, that of those "contacts" which did furnish a positive result after swabbing in Glasgow not one of them later developed the disease.

Climatic conditions.—The majority of epidemics occur in the winter and spring but some occur during warm weather. The Glasgow epidemic started in March, a cold month in this country, and continued in a mild form throughout the summer till the following December, when the cases became more numerous. The Belfast epidemic also occurred during the cold season. It has to be noted, however, that the Glasgow cases did not cease during the summer. It has been stated by eminent medical authorities that in all probability the cold season would see the end of this highly fatal malady in so far as this country was concerned. The history of previous epidemics in other countries does not support this view and it would appear that heat, cold, and moisture have little effect in influencing its activity. True, this summer (1907) there has been a considerable fall in the number of cases in Glasgow, but the disease is by no means stamped out and an increase may be expected during the winter.

Suggested sources of infection.—Randolph says that