absence of miliary tubercles in the meninges in tuberculous meningitis, though a recognized pathological occurrence, is comparatively infrequent, and especially so when associated with their absence also from the lungs and other organs; and the predominance of polymorphonuclear cells in the cerebro-spinal fluid is certainly rare in tuberculosis.

With regard to the reason why tuberculous granulations are not always found in cases of generalized tuberculosis, it may be considered that while general tuberculous infection usually takes the form of a *pyaemia* it may occasionally be only a *septicaemia*, and that the primary tuberculous focus in the first case discharges into the circulation clumps of bacilli with tissue debris, and that these clumps, becoming impacted in the smallest arterioles, cause the formation of miliary tuberculous granulations or "tuberculous pyaemic abscesses" around the blocked vessels, but that in the second case separate bacilli only are discharged into the circulation in considerable numbers, and that these isolated bacilli do not get lodged in the small vessels. The diffuse leucocytic infiltration of the cerebral cortex and the cellulo-fibrinous inflammation of the meninges may be explained as being the result of the irritation of the toxins, and of the bacilli, which have found their way from the blood vessels into the cortical substance and into the cellular tissues of the meninges, these parts especially easily reacting to the tubercle bacillus.

I wish to express my thanks to Dr. H. D. Rolleston for permission to publish this case, and to Dr. Chas. Slater for furnishing the report of the bacteriological examination.

REFERENCE.
¹ *Lancet*, April 13th, 1907.

OBSERVATIONS ON AN OUTBREAK OF MEAT POISONING AT LIMERICK.

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In view of the economic and hygienic importance of the subject of food poisoning, I have thought it well to bring the leading facts revealed by my study of this disastrous outbreak (73 cases with 9 deaths) before a wider circle of the professional public than could be reached by the *Journal of Pathology and Bacteriology*, in which the fuller communication which I have prepared on the subject will appear.

I.—THE OCCURRENCE.

On Tuesday, November 3rd, 1908, at 6 p.m., an alarming attack of illness broke out amongst the inmates of an industrial school for girls at Limerick. The symptoms, ushered in by severe headache, were those of acute gastrointestinal disturbance—nausea, abdominal pain, uncontrollable vomiting and diarrhoea accompanied by tenesmus, and followed, in the severer cases, by the most profound collapse. By midnight, some twenty-eight of the girls were stricken down, and on the following day nearly fifty more became affected, though for the most part not so severely. The first death (that of S. K., aged 13) took place at 7 on the Wednesday morning, after little more than twelve hours' illness. Another child succumbed at 9 that night. On the following day, Thursday the 5th, no fewer than 7 more deaths occurred in rapid succession, the last (that of M. K., aged 13) ensuing at 6.35 p.m., about forty-eight hours after the commencement of the outbreak.

II.—CLASSIFICATION OF THOSE AFFECTED.

The pupils numbered 197, and were divided into four classes. The first or senior class comprised 67 girls between the ages of 13 and 17, and on it fell the brunt of the attack, with 55 illnesses and 8 deaths. The second class, 48 in number (ages between 10 and 13), yielded 10 cases with 1 death. In the third class there were 51 little girls between 7 and 10 years old, of whom 8 sickened—5 decidedly, 3 somewhat doubtfully. The fourth class comprised "babies" between the ages of 3 and 7. There were 31 of these, none of whom took ill. Nor were there any cases amongst the Sisterhood in charge, teachers in training, or servants. Of the 73 cases,

9 died as above stated, and the remainder rapidly recovered, after several days' mild fever, accompanied in several cases by herpes labialis, in others by desquamation of the cuticle, more especially of the fingers. There was no rash. All the recovered cases that were tested (over 20) had agglutinins in their serum, specific for the causative organism.

III.—PATHOLOGICAL ANATOMY.

Assisted by Drs. P. F. Graham (the medical attendant to the institution) and Dr. J. F. Shanahan, I performed, on November 6th, the autopsy of 3 of the cases—namely, S. K., aged 13, the first to die; L. O'D., aged 12½, the only second-class girl who succumbed; and M. K., aged 13, the last to die. The notes were kindly taken by Captain Elsner, R.A.M.C. Eliminating all non-essential details, the following were the chief findings:

Alimentary Canal.—Empty throughout, save for a little creamy fluid; not inflamed, nor ulcerated, nor even hyperaemic, save for a few streaks of capillary engorgement on the gastric mucosa. The mucous membrane of stomach and intestines presented a peculiar pale, swollen, velvety aspect, with here and there patches of white, prominent granules, each as large as a pin's head, projecting under the mucous membrane. They consisted of nodules of tumid lymphoid tissue. Peyer's patches were not tumefied.

The *liver* showed characteristic though not exactly obvious changes in all 3 cases. It was large, soft, hyperaemic, and sprinkled throughout with little, indistinct, pale-yellowish areas or spots. Microscopic examination of the fixed and hardened preparation revealed the most intense fatty degeneration of the liver cells at these places. In one case (L. O'D.) there were areas of haemorrhagic breakdown as big as a pea. The spleen showed no constant change. The kidneys were in a state of cloudy swelling.

The *cardio-vascular system* showed but little change. Endocardium and aortic intima not stained. The volume of the blood was much diminished and the clots were tarry in character. The *lungs* showed only some scattered patches of hyperaemia. The anatomical diagnosis was *cholera nostras* due to food poisoning.

IV.—BACTERIOLOGY.

From practically all of the viscera examined (for details, I would refer to the complete paper), as well as from the discharges obtained from the recovering cases, I succeeded in isolating, either by direct culture or after preliminary enrichment in malachite-green broth, a typical strain of the *Bacillus enteritidis* of Gaertner. The medium used for plating out was Drigalski's litmus-nutrose-lactose-crystal-violet-agar. On it the Gaertner colonies were readily distinguishable by their bluish translucent appearance, vigorous growth, and marked tendency to become confluent. The same colonies were obtained from all three cases examined *post mortem*. Avoiding technical details, I will merely say that morphologically this organism is identical with the typhoid bacillus, and is quite as actively motile. It differs from the typhoid bacillus *inter alia*, in its more rapid growth on gelatine, its ability to clear up milk, and to ferment glucose with formation of acid and gas. It differs from an actively motile strain of *B. coli* in the delicate character of its gelatine colonies, its inability to coagulate milk, to ferment lactose, and to form indol. I could find no constant morphological or cultural difference between this strain of Gaertner's bacillus and the paratyphoid *B. bacillus* (two strains isolated by myself from Irish cases). Neither does it seem to differ morphologically or culturally from the bacillus of Ratn.

Serologically, however, it stands nearer to typhoid than to paratyphoid *B.*, and by comparative agglutination tests I find it to belong to the true Gaertner type (that responsible for the outbreaks of food poisoning at Rumfleth, Haustadt, Morseele, etc., described by van Ermengem and his pupils) and not to the morphologically identical, but serologically distinct, "Flügge-Kaensche" or "Aertryke" type.

I reserve details as to its behaviour on the various coloured and other test media for the complete paper. As regards its pathogenicity for animals, the Limerick strain is very virulent for rats and mice, setting up in mice a fatal epizootic disorder accompanied by yellowish mucoid

or honey-like stools (? mouse-typhoid). Guinea-pigs appear to be immune, at any rate to infection per os, as are also dogs. Rabbits are highly susceptible, not merely to fresh but to old heated cultures administered subcutaneously. A calf, aged 4 months, was killed in seven hours by an injection of 20 c.cm. culture fluid into the jugular vein. The symptoms were severe dyspnoea coming on in a couple of hours, followed by purging and collapse. I have to thank Professor A. E. Mettam, B.Sc., Principal of the Royal Veterinary College of Ireland, for giving the injection, having the animal watched by one of his pupils, performing the autopsy for me, and giving me facilities for the bacteriological study of the cadaver.

V.—MODE OF INFECTION.

From the first, suspicion was riveted on a certain stew which formed the dinner of the first or senior class *only* on Tuesday, November 3rd, at noon. Out of 55 girls belonging to the first class who partook of this stew, 53 sickened and 8 died. The serum of the survivors gave positive agglutination reactions with the strain of Gaertner's bacillus isolated. The serum of two of the first class who had their meal in another room, off different food, and who were not ill, gave negative results. It was found afterwards that one of the two girls who partook of the stew and were *not* ill, consumed only the gravy and potatoes. Their blood gave a distinct positive reaction with the specific bacillus, showing that infection—though unaccompanied by symptoms—must have taken place.

The peccant element in the stew was clearly proved to have been the remains of part of a fore-quarter of beef weighing 38 lbs., which was brought in on Saturday, October 24th. Part of this was cooked and eaten on the following Tuesday, and the remainder was roasted on the Thursday (27th). It was three or four pounds left over from this joint, and allowed to lie in the larder from Thursday till the following Tuesday, that caused the outbreak. This stale piece of roast beef was cut up and added to the stew which formed the dinner of 55 first-class pupils on that day. But how did some second and third-class girls become affected? Subsequent inquiry revealed the fact that four girls (members of the second class) had exchanged their own repast for some of the cold beef in question. All became very ill, and one (L. O'D.) died. Six other girls of this class took cold bacon, with or without a little of the beef. All of these were slightly ill. The bacon is stated to have lain in the larder on the same dish as the beef, and no doubt became infected by contact. The members of the third class to the number of 51 escaped with the exception of 8, only 5 of whom were at all seriously ill, the slight malaise from which the other three complained being ascribed—and no doubt correctly so—to a smart dose of castor oil. Of the 5 who were really ill, 4 received some of the fatal stew from the waitresses (senior girls) who shared their own repast with the little ones. The remaining third-class girl who was ill (A. F.) was found to have occupied a seat at the second-class table, and to have partaken of the cold beef and bacon that were responsible for the illness of members of that class.

VI.—HISTORY OF THE BEEF.

The animal from the carcass of which was cut the piece that occasioned the disaster was described at the inquest as a young Kerry heifer, purchased on June 29th by a certain butcher, who would seem to have attempted, but without success, to fatten it. This butcher seems to have killed the animal on his own premises, on or before October 19th, when he disposed of part of the carcass to another butcher who was the regular supplier of the institution. The contract prices paid by the institution for beef and mutton were 8d. per lb. for the "prime" cuts, and 5d. for the other parts. This piece was sent in at 5d. per lb. by the contractor. No reliable information was obtainable at the inquest as to the condition of the calf at, or shortly prior to, slaughter. From the low price at which the meat was sold to the contractor—3d. per lb.—it seems fair to conclude that the meat could not have been regarded as of "prime" quality. Moreover, the first butcher would appear to have sold the meat at a sacrifice. Two features typical of such occurrences were therefore present in the case. The meat was purchased ready killed by the contractor, and at an unusually low price. The fate

of the remainder of the carcass was not satisfactorily traced at the inquest. The piece sent to the school on October 24th was part of the fore-quarter, weighing some 38 lb. All of this save 12 lb. was cooked and eaten on Tuesday, October 27th, without ill effect. A piece of "ribs" weighing 12 lb. was not cooked, however, till Thursday, October 29th, when it was roasted and partaken of by the teachers without ill effects. Of this joint, about 3 or 4 lb. were left over from the Thursday's dinner, and kept on a dish (together with a piece of bacon) in the larder till the following Tuesday, November 3rd, when it was cut up, most of it put in the stew, and the remainder served out, with or without cold bacon, to girls of the second class. The stew, as already stated, formed the dinner of the first class, but was also obtained by some members of the third class. All who partook of it became ill, with two exceptions, and their serum proved to contain agglutinins specific for the causative organism. All who partook of the beef, as such, also became ill, and also some of those who partook of bacon that had lain in contact with it. The bone of the beef was put in the soup for the "baby" class, and seems to have been innocuous, doubtless because it was thoroughly boiled. As for the stew, that was expressly stated by the cook *not to have been boiled*, but only warmed up. It would have been most interesting to have examined the beef, but unfortunately when I arrived on the scene not a scrap remained. Despite the fact that it must have been very stale, it does not seem to have given rise to observation with regard to odour, taste, or appearance. Experiments which I carried out by inoculating cold beef with the strain of Gaertner's bacillus isolated from these cases showed that the meat became rapidly and completely pervaded with the organism, and yet exhibited no perceptible alteration. The bacillus would actually seem to have a special predilection for muscular tissue, for I have never failed to isolate it from the muscles of animals that had succumbed to experimental infection with it.

In the stew there was also mutton, but for various reasons, needless to detail here, that could not have been the *fons et origo mali*. Moreover, a large piece sent up to me for examination failed to yield Gaertner's bacillus, even by malachite-green enrichment.

VII.—SUMMARY AND CONCLUSIONS.

This severe outbreak of meat poisoning was caused partly by intoxication (cf. the short incubation period), and partly by infection (cf. the cultivation of the organism from the three fatal and two of the recovering cases). The causal micro-organism was the genuine *Bacillus enteritidis* of Gaertner, which must have been conveyed to the sufferers in the beef; and from the history it seems probable that the calf was sickly, and already harboured the bacillus at the time of slaughter. The escape of those who partook of portion of the same carcass on October 27th and 29th may be accounted for either by unequal distribution of the virus, or by thorough cooking which destroyed it. Some of the infective material must, however, have escaped the roasting of the 29th, and, multiplying rapidly, have rendered the whole piece intensely toxic and infective during the five days that elapsed before the fatal Tuesday when it was finally consumed. The practical lesson to be derived from the observation of this occurrence—the most disastrous of its kind hitherto recorded, so far as the writer knows—is twofold. First, it indicates the need there is for the abolition of the private slaughterhouse, and for the inspection of all animals used for human food, both before, during, and after slaughter; secondly, it emphasizes the danger arising from the use of old stale scraps of meat, and especially of beef. If, on economic grounds, such left-over pieces *must* be used up, the only way of avoiding or diminishing the danger would seem to be very thorough and prolonged boiling. Ordinary examination of such meat may fail to discover any grounds for suspicion.

In the foregoing description I have purposely omitted many interesting points of detail, such as the agglutination reactions of the patients' serum, the distribution of the bacillus in the bodies of the victims, etc. These are reserved for the full paper.

In conclusion, I have to express my heartfelt thanks to the Sisterhood in charge of the institution for the full and complete information and other assistance which they

cheerfully afforded me during my investigation of the outbreak. My thanks are also due to Dr. P. F. Graham, physician to the institution, for his assistance and the trouble he took in collecting the patients' serum. I desire also to thank Dr. Shanahan for helping me at the autopsies and in other ways.

THE SCIENCE COMMITTEE

OF THE

British Medical Association.

REPORT CXIII.

THE CONDITION OF THE BLOOD IN EXPERIMENTAL RICKETS.*

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CONCERNING the condition of the blood in rickets there is much diversity of opinion. The majority of authors consider that there is invariably a certain degree of anaemia. Ewing¹ and Cabot,² in their textbooks on haematology, say that there is always a certain degree of anaemia proportionate to the severity of the disease. Cabot, in addition, mentions that examples of polychromatophilia, myelocytes, and nucleated red blood corpuscles are not infrequently observed. Holt,³ Cheadle,⁴ and Ashby,⁵ in their writings on rickets, express practically the same opinion. Not one of these authors, however, quotes any specific example, but merely the conclusions of other observers. Hutchison,⁶ on the other hand, states that severe rickets is often accompanied by no appreciable degree of anaemia; and Pfaunder and Schlossmann⁷ say that in rickets there is nothing characteristic of the blood.

Considering the frequency with which rickets occurs, the blood picture has comparatively seldom been the subject of study. In the literature I have only been able to find three papers based on anything like extensive observations.

Morse⁸ in 1897 reported the result of an investigation into the condition of the blood in 20 cases of active and uncomplicated rickets occurring in children between the ages of 7 months and 2 years. He found the percentage of haemoglobin (as estimated by the apparatus of von Fleischl) to vary between 48 and 77, the red blood corpuscles to vary between 3,508,000 and 5,528,000 per c.mm., and the leucocytes between 5,500 and 18,800 per c.mm. He observed nucleated red cells in three of the cases, all of which presented some enlargement of the spleen, and in some of these, in which the spleen was greatly enlarged, nucleated red cells, both megaloblasts and normoblasts, were very numerous. In nearly all the cases mention is made of some variation in the size of the red cells, and occasionally poikilocytosis was observed. Morse concludes from his observations that most cases of rickets present some anaemia, which, as a rule, varies with the severity of the disease, and that there may or may not be a leucocytosis.

Felsenthal (quoted by Morse⁹) investigated 12 cases of rickets, varying in age from 9 months to 2 years. Three of the patients were very markedly rachitic and had large spleens. He got practically the same result in all the 12 cases. The red blood corpuscles were not decreased in number, or only to a very slight extent, but the haemoglobin was always diminished. Nucleated red cells only occurred in the most severe cases.

Esser,⁹ in a recent paper on the etiology of rickets, discusses the condition of the blood—at least, so far as the number and character of the leucocytes are concerned. He asserts that there is almost invariably—at least, in the early stages—a marked leucocytosis, amounting in some instances to 30,000 per c.mm., and that the nuclei of the polymorphonuclear leucocytes are more lobulated than normal. He does not, however, give any table of his results, nor does he make any mention of the percentage of haemoglobin or number of red blood corpuscles.

According to Cabot,¹⁰ Hock and Schlesinger found that in a considerable number of cases of rickets, with and without splenic enlargement, the number of red blood cells per c.mm. was 2,500,000.

As for the rest of the literature, it consists of reports of isolated, or at most two, examples of rickets examined by

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the one author. Not infrequently, too, some mention is made of splenic enlargement, and in not a few the blood picture was similar to that found in "splenic anaemia of infancy," so that these results are of very doubtful value. More especially is this the case when one considers that the degree of splenic enlargement in splenic anaemia bears no definite relation to the severity of the anaemia, and also that it is very doubtful, in view of recent observations,¹³ if uncomplicated rickets is accompanied by any degree of splenic enlargement; and, finally, as Starck¹¹ has shown, that enlargement of the spleen is as common in non-rachitic as rachitic children.

Moreover, much of the diversity of opinion regarding the relationship of rickets to von Jaksch's anaemia is due, in my opinion, to the want of exact knowledge regarding the blood picture in uncomplicated rickets.

Owing to this scarcity of information regarding the condition of the blood in active and uncomplicated rickets I was led to conduct an investigation into the subject both from the clinical and experimental aspect. In this paper I intend to deal chiefly with my experimental results, but it will be advisable to give in addition a brief summary of the results obtained in the case of spontaneous rickets in children.

I examined 30 cases of active and uncomplicated rickets in children between the ages of 12 and 42 months. In order to control these observations I also investigated the blood of 12 children, who to all external appearances were quite healthy, and who most certainly did not present the slightest rachitic manifestation, and who, it may also be stated, belonged to the same class of society. In only 9 of the 30 rachitic cases was there any degree of anaemia. In 2 of these the amount of haemoglobin was only 5 per cent. below the accepted average, and the red cells in no instance were less than 4,100,000 per c.mm. The majority of the cases, on the other hand, gave notably high blood estimations, so far as the amount of haemoglobin and number of red cells were concerned. For better comparison the cases were divided into five groups, each group comprising an age-period of six months, and the average of each group compared with the average of the controls and the reputed average of authors for corresponding ages. For each age-period the average amount of haemoglobin and number of red cells was in excess of the reputed average, and also of the controls, excepting in one series composed of children between the ages of 18 and 24 months, where the red cells, though still above the normal, were some 800,000 per c.mm. below the average number as found in the controls. Nucleated red corpuscles were exceedingly rare, only being discovered on one occasion, and myelocytes were notable by their absence. In only 2 of these cases was there an unequivocal leucocytosis, the white cells numbering 20,000 and 30,000 per c.mm. The child in one of these cases had been suffering for some days prior to the examination from diarrhoea. Of the other 28 cases, 9 gave a normal or subnormal estimation, and in 19 the leucocytes were moderately increased in number, the maximum being 19,000 per c.mm. Differential counts failed to reveal anything characteristic.

As uncomplicated rickets in children is comparatively rare, I considered it important to corroborate the clinical findings with observations in experimental rickets.

Rickets was induced experimentally in puppies, and periodic examinations of the blood were made before and after the development of the disease. When the rachitic manifestations became very marked the animals were killed, and the histology of the haematopoietic organs studied. In the results recounted below, however, I have not discussed the histological findings in these organs in any detail, as I intend in a later communication to deal with that aspect of the subject.

The blood examinations were always made at about the same time of the day, between 3 and 5 p.m. The sample of blood was taken from a vein of the ear, after the part had been shaved, the haemoglobin estimated by Gowers's haemoglobinometer, and enumerations of the red and white cells made with the Thoma-Leitz haemocytometer. Gowers's solution was used as the diluent for the red cells, and a 3 per cent. solution of acetic acid, tinted with methylene blue, for the white cells, the dilutions being 1 in 100 or 1 in 200 and 1 in 10 respectively. Films were also made and stained with Jenner's fluid, and a differential