bone marrow showed a myeloid/erythroid ratio of 11:1. A relative increase in myelocytes was still present. When she left hospital on February 10 she had been free from infections since splenectomy and was in good health.

She was readmitted on May 26 for repair of a uterine prolapse. Since leaving hospital in February she had had

FIG. 2.—White blood count during the immediate post-operative period.

no further infections. The arthritis has not been unusually troublesome. The physical findings were unchanged. Blood counts (Fig. 1) showed a total number of white cells which was normal (between 6,000 and 8,000), but the percentage of polymorphs was often low, ranging between 20 and 60%. The number of polymorphs, however, was always above 1,500 per c.mm. The sternal marrow on June 21 was normal, with a myeloid/erythroid ratio of 5.5:1.

The prolapse was repaired by Mr. Arthure on June 21. Convalescence was interrupted by a respiratory infection, a burst abdomen, congestive heart failure, and an axillary vein thrombosis. However, she overcame these complications and left hospital on August 28.

When last seen, in June, 1957, she was well, apart from mild rheumatoid arthritis, and her blood count was normal.

Discussion

The severe leucopenia originally found in this patient was associated with crippling ill-health because of repeated infections, many of them serious. A few hours after splenectomy the leucocyte count became normal, and remained so, although the granular cells were sometimes at the lower limit of the normal range. The tendency to infection was successfully corrected. The rheumatoid arthritis was unaffected, remained mildly active, and may have been the cause of the occasional low neutrophil counts. Hutchison and Alexander (1954) describe a similar case of a woman of 50 who had had rheumatoid arthritis for twenty years. She was repeatedly admitted to hospital between 1950 and 1953 with infections and a persistent leucopenia, the neutrophil count ranging from nil to 730 per c.mm. An enlarged spleen, weighing 300 g., was removed in February, 1953, whereupon the leucocyte count rose to 5,000 per c.mm., the neutrophils to 2,500. Microscopy of the spleen showed no evidence of excessive phagocytosis, and neutropenia was thought to be due to maturation arrest. They review the literature concerning splenic neutropenia, and consider in particular the 21 cases recorded in which splenectomy led to recovery. The spleen showed signs of excessive phagocytosis in 11, 6 of whom had rheumatoid arthritis; in the other 10, of whom 2 had rheumatoid arthritis, the spleen did not show phagocytosis, but there was evidence of maturation arrest. In our patient the signs also were more suggestive of maturation arrest than of excessive phagocytosis.

Splenic neutropenia should therefore be considered when a patient with Felty's syndrome has repeated infections,

persistent fever, and ill-health which may be prolonged (Doan, 1955). The improvement after splenectomy can be impressive.

Summary

The results of splenectomy are described in a woman aged 68 with Felty's syndrome and neutropenia.

Rheumatoid arthritis had been present for seven years; its activity was unaltered by the operation.

She was admitted to hospital because of recurrent fever following an attack of herpes zoster seven months previously. Hepatomegaly and splenomegaly with a persistent leucopenia (total count usually below 2,000 per c.mm.) and granulopenia (polymorphs below 100 per c.mm.) were found; the leucocyte count was unaffected by treatment with cortisone. She developed many infections during the next six weeks.

Splenectomy was performed, the spleen weighing 705 g. and showing non-specific hyperplasia of the pulp with congested sinusoids.

Four hours after the splenic pedicle was tied the leucocyte count rose to 4,200 per c.mm. and has since remained at a normal level. The polymorphs have ranged between 60% and 20%, but the total has always been above 1,500 per c.mm. The patient has been afebrile and free from infections.

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Medical Memorandum

Infection of Bone and Joint by Salmonellae

Abscesses and bony infections caused by the more invasive salmonellae, such as *Salmonella typhi*, are well known; it is not common, however, to find systemic infections of this nature caused by the less invasive members of the group, such as *Salm. typhimurium*. Neither are reports of such infections by *Salm. cholerae suis* frequent in this country (Boycott and McNee, 1936; Schwabacher, Taylor, and White, 1943; Laylee, 1957), although in America Saphra and Wassermann (1954) reported on a series of 329 patients infected with this organism, in which there were 144 instances of septicaemia with a positive blood culture and 53 cases of gastro-enteritis. The American variant of *Salm. cholerae suis*, which may be presumed to have infected the majority of Saphra and Wassermann's cases, is known to be much more invasive than the European or *kunzendorf* variant, and differs from it in a number of biochemical and antigenic particulars.

The two cases reported here, of infection with *Salm. cholerae suis* var. *kunzendorf* and *Salm. typhimurium* are presented because they demonstrate the circumstances under which may occur systemic infection by organisms which have poor invasive powers, and also for the intrinsic interest of the clinical findings.

CASE 1

A woman of 60 with diabetes of five years' duration was admitted in a debilitated state but with no abnormal physical signs. Her blood glucose level was 280 mg. per 100 ml., her temperature was 100.2° F. (37.9° C.), and she had severe ketosis. The diabetic condition was easily dealt with, but the fever remained. A leucocytosis of 12,000 cells per c.mm. (72% neutrophils) and an E.S.R. of 117 mm./hr. (Westergren) was found. A radiograph of the chest showed a diffuse fine nodular mottling in both lungs, and a diagnosis of miliary tuberculosis was considered. She was accordingly treated with streptomycin and P.A.S.

After a week of this treatment the high pyrexia and leucocytosis remained; serological investigations showed a titre of 1/5,120 against a non-specific *Salmonella* H suspension and of 1/320 against *Salm. paratyphi* C O, but less than 1/20 against *Salm. typhi* and *Salm. paratyphi* A and B. This clearly indicated an infection with *Salm. paratyphi* C or a closely allied organism, and a subsequent blood culture produced a growth of a member of the *Salmonella* group, sensitive *in vitro* to streptomycin, chlortetracycline, and chloramphenicol, and later identified as *Salm. cholerae suis* var. *kunzendorf*. Chloramphenicol (1.5 g. daily) was now administered, and the patient's temperature fell to normal in 48 hours. After a 10-days course her condition had greatly improved; blood culture at this time was sterile.

Ten days later she coughed up an ounce (28 ml.) of bright-red blood for which no cause could be found in the nose or throat; her temperature rose to 100.4° F. (38° C.) and her condition deteriorated. The appearance of the chest x-ray film was unchanged; the leucocytosis remained at 13,600 cells per c.mm. (81% neutrophils), while a blood culture once more produced *Salm. cholerae suis*.

Chloramphenicol was given for three weeks, and streptomycin at the same time for six weeks; a fortnight after this was begun a course of tetracycline (3 g. daily) was given for three weeks; the patient was also transfused with fresh blood.

A week later she complained of a sudden severe stabbing pain in the small of the back which gradually ceased during the next three days. A few days later she was found in an unconscious state, from which she recovered gradually and spontaneously after several hours, some weakness of the right leg being the only residual physical sign. A radiograph of the skull and lumbar spine at this time showed a normal appearance.

Her general condition remained very poor; the temperature was still 100–101° F. (37.8–38.5° C.), the E.S.R. was 112 mm./hr., and the leucocytosis had advanced to 29,200 cells per c.mm. (94% neutrophils). Two pints (1.14 l.) of blood were given, and 4 g. of chloramphenicol daily for six days was followed by 0.25 g. intravenously 4-hourly for 24 hours; penicillin was also given to deal with a mild urinary infection. Her temperature now remained normal, and treatment was directed at relieving congestive heart failure and dealing with hypoproteinaemia. At this time, for the only occasion during her illness, *Salm. cholerae suis* was isolated from the faeces; it could still be recovered from the blood. A radiograph of the spine showed a rounded soft-tissue shadow in the centre of the abdomen, and osteomyelitis of the third, fourth, and fifth lumbar vertebrae with collapse of the body of the fourth.

On the day following this radiograph a large abdominal mass was palpated near the body of the fourth lumbar vertebra. This was thought to be an aortic aneurysm, but because of the patient's condition laparotomy was not undertaken, and she died 10 days later.

Post-mortem Examination.—Apart from the findings in the abdomen and pelvis there were considerable emaciation, some pulmonary oedema, and a terminal pyelonephritis and cystitis. A large mass found in the abdomen consisted of a number of structures; there was an osteomyelitis of the bodies of the third, fourth, and fifth lumbar vertebrae with collapse of the body of the fourth. The aorta lying immediately in front of this had a perforation 3 mm. across in its posterior wall, and was surrounded by organizing blood clot, forming a false aneurysm; adherent to it was a mass of bowel, having several enlarged lymph nodes in its mesentery. *Salm. cholerae suis* was recovered from the lymph nodes, the blood clot of the false aneurysm, and the site of the osteomyelitis.

There was no evidence of pulmonary tuberculosis or of any cerebral vascular disease.

CASE 2

An emaciated man of 75 was seen with swelling of the right shoulder and inability to use the right arm. He could

not give a clear history, but admitted increasing tiredness for a year.

There was a fluctuant swelling of the joint and wasting of the right shoulder-girdle muscles with enlarged and tender axillary lymph nodes; no other abnormal physical signs were found. A radiograph showed only osteoarthritis of the acromio-clavicular joint. His temperature on the first two days after admission rose in the evening to 100° F. (37.8° C.). His E.S.R. was 104 mm./hr. (Westergren), and his total leucocyte count was 9,600 per c.mm. (neutrophils 76%, lymphocytes 22%, monocytes 2%). Aspiration of the joint produced an ounce (28 ml.) of thick blood-stained fluid which yielded a heavy growth of *Salm. typhimurium*.

This organism was obtained from the joint on one further occasion. Serological evidence of infection was found (titres of 1/800 against H and 1/1,200 against O suspensions); the organism was never found in the faeces. The sera of the patient's wife and daughter were investigated for evidence of infection, with negative results. Chloramphenicol (15 g. total) was administered, the shoulder became painless, the swelling did not recur, and his mental condition became much clearer. He was discharged after five weeks in hospital in excellent general condition, but with very limited movements of his shoulder-joint. A radiograph taken a few days before discharge showed well-marked osteomyelitis in all the bones round the shoulder-joint, with osteitis eroding the acromion process.

DISCUSSION

Among the *Salmonella* group of organisms, *Salm. typhi* and *Salm. paratyphi* B are the two most frequently responsible for bone infection. White and Meynell (1956) found only 28 reports of osteomyelitis caused by other members of the group, of which 17 were due to *Salm. cholerae suis* and 4 to *Salm. typhimurium*.

It is rarely possible to demonstrate the source of infection by *Salm. cholerae suis* in man. The natural host is the pig, and the organism is frequently found in cultures of the animal's mesenteric lymph nodes (Wilson and Miles, 1955); a probable source of infection is therefore undercooked pork.

Neither of the two organisms in this account seems to be capable of systemic invasion unless the resistance of the patient is diminished; this was clearly the case with the first patient. The second patient was an elderly man with bad teeth and in a poor state of nutrition; it required six days to saturate him with ascorbic acid instead of the normal one or two days.

It has been reported by several authors (Boycott and McNee, 1936; Goulder, Kingsland, and Janeway, 1942; Schwabacher *et al.*, 1943) that the formation of an abscess or similar localization in *Salm. cholerae suis* infection is accompanied by a very high leucocytosis. In the first patient, although the site of the osteomyelitis did not at once declare itself, the persistence of the leucocytosis prompted repeated radiographic examination until the lesion was eventually found. In the second case there was no leucocytosis, and in spite of the radiographic changes the organism may not have invaded the bone to any great degree.

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J. M. TALBOT, M.D., Dip.Bact.,
Senior Lecturer in Bacteriology,
King's College Hospital and Medical School.

J. A. HUNT, M.B., B.S.,
Lately Senior House Officer to the Diabetic Department,
King's College Hospital and Medical School.

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