gauze and solids. On the sixth day the patient was dressed under an anaesthetic. The old wound had been transformed into a granulating surface, as mentioned above, but the temperature, as is so often the case, rose after the dressing.

SECONDARY INFECTIONS OF JOINTS IN ACUTE MEDICAL AILMENTS.

BY

LIEUT.-COLONEL G. H. EDINGTON, R.A.M.C.(T.F.).

SECONDARY infections of joints may occur from wounds or other surgical lesions in the neighbourhood or in a distant part of the body, or they may occur as a complication in medical cases. It is with the latter group that I propose to deal, but I would like in passing to mention examples of the others.

Joint Infections Secondary to Wounds or other Surgical Lesions.

These cases fall into two classes:

1. A wound in the neighbourhood of but not primarily involving a joint becomes septic, and the process spreads directly into the joint. One of the best examples of this is a septic wound or abrasion on the dorsum of a finger, over an interphalangeal joint. The bursa may become involved, in which case septic arthritis, followed by ankylosis, will most probably ensue.

2. Joints may become the seat of pyaemic infection, the primary lesion being in a distant part of the body. As an example of this there occurs to me the case of a young lad I saw some years ago, and in whom removal of enlarged turbinal bones was followed by pyaemic infection of wrist and knee joints.

Secondary Joint Infections in Medical Cases.

It is, however, with joint infections which occur as a complication in medical cases that I am immediately concerned. Several examples have come to my notice within the last few weeks in this hospital, and form the basis of the following remarks.

CASE I.—*Bronchopneumonia, Pneumococcal Abscess of Knee, and later Pneumococcal Abscess in Buttock.*

Pte. B., aged 20, admitted to a medical ward under the care of Captain De Boer on March 15th, with cough and pain in chest. Examination showed bronchopneumonia, chiefly in left base. Two days later complained of pain in right knee, which began to swell. Subsequently whole limb became swollen. Needle withdrew from joint some turbid fluid which showed pneumococci in film and in culture. He was transferred to surgical division, where joint was opened and drained. One month later large abscess formed in left buttock; pus contained pneumococci.

It was not possible to obtain a history of the date of onset of the pulmonary condition, but it was several days before admission to hospital. The joint condition was a complication rather than a sequela, successive consolidation of different areas of lung tissue being noted during the healing of the joint lesion.

There was nothing in the history to suggest any reason for the implication of the joint in the infection.

CASE II.—*Coxitis (Streptococcal); Empyema (Pneumococcal).*

Pte. H., aged 28, was operated on for empyema of left chest on March 9th, the pus showing micrococci encapsulated. The empyema had followed post-influenzal pneumonia, during the third week of which he began to have pain in the right leg. At time of operation on the empyema there was some fullness and pain in right hip, and extension was applied to limb. Ten days later there was fluctuant swelling occupying Scarpa's triangle and lower part of iliac fossa. Pus drawn off by syringe showed streptococci in film and in culture. The abscess was opened, and the cavity found to correspond with lower part of iliacus muscle, extending downwards and inwards behind femoral vessels. No gross communication with hip-joint discovered, but signs of coxitis were unmistakable, and left no doubt as to origin of the abscess.

The pathological relationship of the coxitis to the empyema is at first sight somewhat obscure. But primary suppuration of a joint is so uncommon that we are justified in considering it in the present case to be directly related to the chest condition, in which there was probably a mixed infection.

There was nothing in the history to explain the joint implication.

CASE III.—*Suppuration in Knee-joint during Alleged Cerebro-spinal Fever.*

Chief Officer T., aged 31, was admitted from another hospital to the isolation ward, under Lieutenant N. S. Gilchrist, on March 20th, with history of headache and fever beginning fourteen days previously. The condition had been diagnosed "cerebro-spinal fever," and turbid fluid obtained by lumbar puncture. The fluid did not contain any meningococci, but antimeningococcal serum had been injected. He did well as regards general symptoms, but the left knee had become swollen, and the condition was regarded as metastatic.

On the patient's admission to the isolation ward Lieutenant Gilchrist did not find any signs of meningitis. He aspirated the knee and withdrew thin purulent fluid containing many pus cells and a few scattered extracellular Gram-negative diplococci; culture failed. The following day aspiration was repeated and the fluid again showed many pus cells, but no organisms in film. Culture gave chains of streptococci, and many weakly Gram-positive bacilli not corresponding morphologically with any known pathogenic organisms.

A history of gonorrhoea two and a half years previously was elicited, and there was doubt as to whether the knee condition was not a late sequela of gonorrhoea. As there were during his stay in isolation ward no signs of cerebro-spinal fever, he was transferred on March 27th.

We have here three cases in which joint infection occurred secondarily to a medical condition, and the points which come up for discussion are: (1) Symptomatology; (2) the exciting cause of the joint implication; (3) its influence on the course of the disease; (4) prognosis; and (5) the treatment of the joint condition.

1. *Symptomatology.*—It is not my intention to spend time on the symptomatology of synovitis, either general or with special reference to individual joints; I would, however, very briefly refer to the joints affected in the cases just mentioned.

In a patient suffering from an acute ailment such as pneumonia the occurrence of pain in a joint demands investigation. In the case of the knee inspection alone is often sufficient, the filling up of the natural hollows of the joint being an early feature. In the hip, however, marked swelling in the early stage is unlikely, and careful examination of this joint should be made. If coxitis be unrecognized in the early stage and allowed to go untreated, it may be found later that subluxation has taken place.

2. *Exciting Cause.*—It is usual to explain the implication of the joint as a metastasis occurring in a part whose natural power of resistance has been lowered; and in support of this explanation trauma is usually invoked. I do not deny that diminished power of resistance has allowed of a successful microbic attack; but even if such be admitted, it does not bring us much, if any, nearer to an explanation of the occurrence. We are still facing the problem of what has caused the lowering of the resisting power of the part.

In none of the cases related above was there any history of an injury to the joint; this is important when we bear in mind the very human tendency to hark back. It has always seemed to me that the story of precedent injury, frequently trifling, of which so much is made when viewed in the light of subsequent events, often rests on a slender foundation. We meet with it in acute cases, and also when investigating cases of tuberculous joint disease.

Even if we assume that secondary implication of a joint points to severity of the primary infection—large dose, or particularly virulent strain—we have still to answer the question as to the choice of location of secondary infection. Here we are in most cases thrown back again on theory. In the cases just given I am not able to throw any light on the causation.

3. *Influence on Primary Disease.*—It seems to me that the occurrence of joint infection must have an appreciable effect on the course of the disease. It may or may not be evidence of severity of infection; but it undoubtedly adds to the patient's sufferings, and imposes an additional tax upon his powers of recovery. Further, the special treatment of the joint lesion often imposes on the patient a degree of immobilization not only irksome, but, in the case of chest affections, harmful by increasing the risk of hypostatic congestion of the lung.

4. *Prognosis as to Joint.*—The prognosis with regard to the joint depends on the degree of infection and consequent reaction of the articular tissues. For example, arthritis involving the cartilages spells as a rule ankylosis; while synovitis, especially where the effusion is not purulent, may be followed by fairly complete restitution.

5. *Treatment.*—The joint must be kept at rest, attention being paid to the position of the limb. As a rule, pain causes the patient to avoid movement of the affected limb; but while Nature teaches him so much she does not go far enough, and it will usually be found that the position adopted is faulty. Such a fault is serious, and if not corrected will lead to contracture of muscles, requiring prolonged after-treatment. Should ankylosis occur, permanent deformity, with greatly impaired function of the limb, will result. In consequence of softening of ligaments, faulty position may end in pathological subluxation, with incurable deformity. The hip-joint is best kept at rest by extension weight and pulley. This prevents flexion of the joint, and takes strain off the capsule, thereby minimizing the risk of subluxation. The knee should be put up on a straight posterior splint; the elbow at right angles; the shoulder in abduction.

If distension by effusion occurs, aspiration, repeated if necessary, should be employed; if effusion be frankly purulent, drainage of joint is called for. Any operative procedure must be carried out with strict antiseptic precautions. It is necessary to emphasize this point, as observation shows me that the presence of pus seems to some minds to indicate that antiseptic precautions may be ignored. It should not be forgotten that to secure an aseptic result in a case of abscess is a proof of surgical skill greater than that required for the successful termination of a case of abdominal section.

I do not syringe out the cavity, but content myself with inserting a rubber drainage tube of suitable calibre. The discharge which comes from the tube drains into an abundant dressing of antiseptic gauze, over which is placed absorbent wool, and the whole secured with bandage. The gauze which I use is Lister's double cyanide, damped with carbolic watery lotion (1 in 20) and not otherwise sterilized.

No passive movement should be undertaken till the wound is healed, or, in the event of no operative measures having been required, till inflammatory signs have subsided, and then the utmost gentleness is necessary in order to minimize the risk of exciting a recrudescence. It must be borne in mind that the absence of signs of inflammation does not assure absence of pathogenic microbes; and well-meant efforts may set agoing a fresh attack of joint mischief.

My experience of vaccine treatment is too limited for me to express an opinion.

Discussion.

In the discussion which followed the reading of the paper before a medical meeting in a military hospital abroad the following remarks were made:

Colonel TUBBY (Consulting Surgeon, E.E.F.) said that in addition to its occurrence in pneumonia, secondary arthritis occurred in a number of diseases. He instanced diphtheria, dysentery (and in passing referred to a note on dysenteric arthritis by Captain Moorhead, R.A.M.C., in the *BRITISH MEDICAL JOURNAL*, March 25th, 1916), erysipelas, measles, scarlet fever, variola, typhus, typhoid, malaria, and Malta fever.

If it were realized that a joint cavity was in many ways comparable to a lymphatic sac, it would be easy to comprehend the implication of joints in diseases of infective origin. In health the synovial membrane secreted sufficient fluid to lubricate the joint surfaces. In disease the conditions entirely changed. A profound vasomotor disturbance was set up in the abundant vessels of the perisynovial tissues, and an extensive osmosis took place into the joint, converting it from a sac whose surfaces were closely approximated into a bag filled with fluid. In some diseases this fluid contained the causative micro-organism, in others it was believed toxins only were formed, the products of bacteria in the synovial fringes and perisynovial tissues. Research on this point was necessary, because toxins should not be expected to set up purulent changes in the effusion. The difference in the amount of exudation appeared to depend upon the fact that many joints were not supported by muscles, and in some instances, such as the knee, elbow, and ankle, were practically subcutaneous. There was therefore very little resistance, mechanically, by the tissues to effusion, and its presence was evident at an early date—an important point in diagnosis and treatment.

The absorption of effusion in superficial joints was often slow because they lacked, as in the hip and shoulder, the continual pressure effects of deep and powerful muscles. When, however, in these last-named joints an effusion persisted, it often became purulent, and ankylosis was a common result. The character of the effusion depended upon the exciting cause and the time it persisted.

Four conditions were found in joint infections: (1) slight synovitis; (2) fluid effusion; (3) the foregoing, with infiltration of perisynovial tissues; (4) destruction of cartilages. Prognosis was good in (1) and (2), doubtful in (3), and bad in (4), with this exception, that recovery in pneumococcal cases was often good, even if pus had formed, provided the case was recognized early and incisions made.

He referred particularly to bone and joint affections in typhoid fever, and suggested that similar lesions might occur in paratyphoid. Typhoid fever was frequently followed by lesions of spine, ribs, or tibia, and by arthritis. Of late years the lesion of the spine had attracted a deal of attention. It began in the medullary part of the bodies, and spread to the discs and joints. It came on during convalescence, and resembled Pott's disease, but was much more acute, a boss forming in two or three weeks. It was very amenable to treatment, rest in bed with the spine supported on a pillow causing, in nine to ten weeks, disappearance of the boss. The natural curve reappeared and function was restored in about nine months.

The surgeon must beware of sudden subluxation from softening and lengthening of ligaments. He was in favour of draining the knee-joint by opening from behind over the condyles after dividing the inner and outer heads of the gastrocnemius.

Major CHOYCE, R.A.M.C., believed that the pneumococcal variety of arthritis was much commoner than was generally recognized, not only as a secondary complication of definite pneumococcal infections, but also in certain of the exanthemata, etc., in which the presence of the pneumococcus would not be expected unless specially looked for.

Writers had usually classified the cases into primary and secondary; but really all cases were secondary to some distant focus, although that need not necessarily be in the lungs. The condition was a pyaemic manifestation due to settlement of pneumococci travelling in the blood from some focus such as the ear, throat, or lungs.

In children the arthritis was often of the so-called primary variety, in that it was not associated with pulmonary disease, though probably in a large proportion of the cases there was pneumococcal infection of the ear. In adults it was rare to find the lungs quite clear, even in the so-called adult primary type—that is, where the disease was not associated with lobar pneumonia.

All degrees between the slightest and the most severe occurred. If primary cases were defined to mean those in which definite lobar pulmonary pneumonia did not precede the arthritis, it was convenient to describe five clinical types, namely:

1. The ordinary "primary" case seen in children, often in infants. The child was apparently well, but might have otorrhoea, when an effusion rapidly appeared in one large joint—usually knee, shoulder, or hip. The overlying skin generally, but not always, became red; the patient's temperature rose to a moderate degree and showed a daily swing between about 99° and 101° or 102°. The child resisted handling or movement, but the general and local disturbance was obviously less than occurred in streptococcal or staphylococcal articular infection.

2. The "primary" case seen in adults was rare, but more severe than in the child. Exquisite pain and tenderness, resembling that of acute rheumatism, might be present, but here again the constitutional symptoms were less than would be expected from the pyarthrosis. Careful examination and inquiry would generally elicit some evidences of pulmonary involvement, often abortive. He mentioned the case of a man admitted with pleuritic pain and slight local signs of bronchopneumonic type. These rapidly cleared up, but within two days he had pneumococcal arthritis of the right shoulder. In turn, at intervals of two days, the left hip and right knee became involved. The shoulder and hip cleared up with rest, etc., without surgical interference, but the knee-joint did not improve. It was aspirated and characteristic thin green odourless

fluid withdrawn. Temporary improvement was followed by recrudescence, and aspiration with washing out of the joint through two hollow needles was adopted. As this did not suffice, the joint was opened, a quantity of coagulated material washed out, and the wound closed. Improvement was slow but steady; bacteriological examination of his blood revealed the continued presence of pneumococci.

3. The so-called adult "secondary" type was severe and dangerous. It usually arose after the crisis of severe lobar pneumonia, but might occur earlier, and it might involve more than one large joint. After the crisis the temperature rose again, and the joint became hot, tender, full and painful on movement. In other cases the local signs were subacute, but the complication proved too much for the enfeebled patient, so that the prognosis of this type was always grave.

4. The variety in which the articular condition was but an expression of a general and overwhelming pneumonic toxæmia was rare. Intoxication might be so rapid and so profound that the patient neglected to draw attention to his joint at all. Such cases were always fatal. The temperature chart might show a plateau arrangement; in the other types the temperature swung daily between 99° and 103°.

5. A fifth variety sometimes seen had a more gradual onset, ran a slow, persistent, but ultimately favourable course, and was difficult to diagnose from tuberculosis.

Etiology.—Neither sex nor trauma seemed to have any causative influence. The disease was much commoner in infancy and childhood, and became progressively rarer as age advanced. It was relatively frequently associated with exanthemata.

The joint affected was usually the knee, shoulder, or hip—usually one of them, but sometimes all three. In mild cases the synovial membrane and subsynovial tissues alone were affected; they were reddened, juicy, and infiltrated. Frequently the periarticular tissues were oedematous and infiltrated. In bad cases the cartilages and bones might be eroded, and there was then danger of resulting limitation of function and even of ankylosis. The pneumococcus seemed to die out early in the synovial fluid, but could then sometimes still be found in the perisynovial tissues.

The fluid contained in the joint varied from a turbid, greenish, odourless serum to a thick debris containing fibrin that might be blood-stained in severe cases.

Local Treatment.—In mild cases rest alone sometimes sufficed, but aspiration was often necessary, and in many cases initiated a cure. It might be advisable to introduce two needles and to flush through with normal saline. If the inflammatory signs progressed, the joint should be opened, washed out, and closed; if that failed, drainage should be established, but the tubes removed at the earliest possible date lest secondary infection from the skin should occur. Movements, both passive and, later, slight active ones, should be instituted at an early date.

Before closing (Major Choyce continued) I should like to mention two other cases of secondary infections of joints at present in No. 19 General Hospital, which, though not pneumococcal, yet seem to me interesting. The first, a sergeant, is an object lesson on the dangers attendant on the use of beautiful gold American dental bridges. This man came in with a subacute arthritis of one knee with great effusion and pain and some elevation of temperature. In searching for a cause, we, of course, examined his beautiful set of teeth. At the edges of the bridges there was a blue line. So, having gained his consent, I removed £20 worth of work. Underneath was a collection of debris with the most appalling stench, which quite convinced the patient of the truth of my statement that it is practically impossible to keep bridges clean. His knee is now rapidly clearing up—effusion and pain have gone, and movements are returning.

The other case has caused me much speculation as to its etiology. The man was admitted with typhoid, which began with a good deal of bronchopneumonia. Then he developed staphylococcal pyelitis of one kidney, and this was followed by arthritis of one knee and hip. The effusion in the hip was sterile; that in the knee yielded staphylococci on bacteriological examination, and the same organism was found in his blood. The typhoid had been bacteriologically proved. Therefore he had both enteric

and staphylococcal pyæmia. Is it possible that the second organism gained access to the blood through a typhoid ulcer? I am glad to say that the patient recovered sufficiently to be sent to England.

DEATH AFTER NITROUS OXIDE-OXYGEN AND SPINAL ANAESTHESIA.

By WILLIAM E. ROBINSON, M.D. OXON.,
ANAESTHETIST TO THE WEST LONDON AND ROYAL WATERLOO HOSPITALS.

UNTIL I read the fatal case reported by Dr. W. J. McCardie in the *BRITISH MEDICAL JOURNAL* of July 22nd it had not occurred to me that there was a possibility of death from the continuous use of nitrous oxide gas and oxygen, so safe has it always seemed to me and so excellent a friend as an accompaniment to a spinal anaesthetic when the patient is nervous or likely to be subjected to the inconvenience of the Trendelenburg position during the operation. Yet following close on Dr. McCardie's case I have a similar fatality to report, occurring in my hospital practice on a particularly hot July afternoon.

The patient, a woman aged 45, had suffered from metrorrhagia for two years and was admitted to the Royal Waterloo Hospital for hysterectomy.

She was a fat, unhealthy-looking subject, very anaemic and very nervous. She had never enjoyed good health, having had many attacks of bronchitis. Her heart was apparently of normal size, but of this one could not be sure owing to the size of the breasts. The heart sounds were normal; there were no adventitious sounds. The pulse was small, rapid, and thready. It was not a nice case for a general anaesthetic, but one in which, in my opinion, an intraspinal injection followed by continuous gas and oxygen would give an excellent anaesthesia for the operation and a quick recovery afterwards. No morphine had been injected previously to the operation. At 3.15 p.m. I injected 0.6 c.cm. of stovaine (Billon), a solution composed of 10 cg. stovaine in 1 c.cm. of normal saline.

The anaesthetic acted almost at once, and at the same time the patient became even more pale; she was extremely nervous and begged me to give her something to send her to sleep. At 3.25, ten minutes after the injection of stovaine, I commenced giving gas and oxygen. This I give in an ordinary gas bag, into which are two tubes—one for oxygen and one for gas. After one bagful of pure gas, I turn in oxygen and gas and then start rebreathing. In this way the patient is quickly anaesthetized, and continues unconscious and of a good pink colour. The mixture in the bag I change about every five minutes. In the present case the bagful of gas was more than enough to anaesthetize the patient. I went further than usual—that is, to jactitation—but the admission of oxygen quickly relieved her, and she commenced the regular snoring breathing one is accustomed to.

The patient had meanwhile been got ready for operation; I therefore gave the signal for starting and the patient was turned into the Trendelenburg position. At the first incision the patient's blood was noticed to be extremely watery in appearance—a very pale red.

At 3.30—exactly fifteen minutes after the injection—the patient vomited. This vomit was due to the stovaine, evidence of toxicity which invariably comes on at the same time after every injection, and which usually passes off leaving the patient a little faint, but nothing more; when this period is over, I have never seen any further cause for anxiety in a subject anaesthetized in this way. The mask was removed from the patient during the vomiting, and she became partly conscious. The vomit over, I restarted the gas and oxygen, and the patient breathed beautifully, was a perfectly good colour, and apparently everything was as it should be. At 3.40, whilst the uterus was being pulled up from the pelvis, the patient again vomited. I again removed the mask and wiped out the mouth, but this time her breathing did not recover; she made a few swallowing movements, and that was all. Her colour was perfectly good; her pupils partially dilated. There was no obstruction by vomit in the larynx.

I immediately felt for heart beat, but there was none. Strychnine was at once injected, ether was poured into the abdominal cavity, and the heart was massaged through the abdominal wound.

Attempts at artificial respiration failed to arouse any response. It was clear the patient had died from syncope during the attack of vomiting, death occurring just under half an hour after the injection of stovaine, and after twenty minutes of gas and oxygen, during which there had been one break.

Post-mortem Examination.

Dr. R. C. Jewesbury reported as follows: Right lung adherent to chest wall; bases of both lungs congested. Heart large and very fat; walls extremely flabby and soft; no valvular disease. Liver very fat, weighing 58 oz. Uterus weighed 2 lb., showing a large fibroid in its anterior wall. Brain and other organs healthy.