REPORT and COMMENTARY

on

A SERIES of CASES of

"ACUTE OSTEOMYELITIS"

Presented in Competition for

The Sir Robert JONES PRIZE in

ORTHOPAEDIC SURGERY

and

THE PATTISON PRIZE in

CLINICAL SURGERY

JUNE 1932

by

JAMES MACFARLANE, JR.
ACKNOWLEDGMENT

I am deeply indebted to Professor John Fraser for his kindness in allowing me to make use of six of his Cases for the purpose of this Commentary, and for permitting me to have access to the more general statistics.
PREFACE.

In Hospital practice Osteomyelitis forms a considerable proportion of the cases of Bone Disease. We have seen, in the short space of one month, two little fellows, hale and hearty a few hours previously - suddenly taken ill with pains in the leg - admitted to Hospital and all the resources of medical knowledge applied to try and save them, and yet they passed away.

Each Out-patient day at the Infirmary brings young adults with halting step to have their bones X-rayed or discharging sinuses examined.

These facts, and the increasing debate on the treatment of this disease, have prompted this study. It seems that there is a call for a full consideration of the problem, to enable us to estimate the value of each individual type of operation.

In the literature there is much uncertainty - fads and fashion and argument. (See page 156).

Are the operations justified by the results?
For these reasons I have chosen for discussion the following six cases of osteomyelitis.
THE OBJECT.

The primary object of the present paper is to discuss the clinical entity of acute osteomyelitis - and in particular the results of various forms of treatment, with special reference to cases (six in particular) treated in Wards 7 and 8 of Edinburgh Royal Infirmary.

In the main, we propose to limit the discussion to acute primary osteomyelitis, and to forms due to Staphylococcus aureus.

In addition there is a Report on the Statistics of all cases of Osteomyelitis treated in Wards 7 and 8 between the year 1925 and 1931.

Results will be considered under four headings -

(1) Immediate Mortality.
(2) Cured.
(3) Preservation of the Limb.
(4) Recurrence.
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**CASES of OSTEOMYELITIS in Wards 7 and 8 1925 - 1931.**

**STATISTICAL INVESTIGATION**

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**Summary of New Cases**

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**Average age of New Cases**
Fig. 23. Maximal points of tenderness.
Fig. 24. Maximal points of tenderness.
Fig. 25. Illustrating Incision.
Fig. 26. Showing Trephine Opening.
Fig. 27. Wound - before Winnet Orr Treatment
Fig. 28. Same wound eight weeks later.
Fig. 29. Illustrating Diaphysectomy.
Fig. 30. Chronic Osteomyelitis.
Fig. 31. Demonstrating Involucrum and Cloacae formation.
SIX CASES OF

ACUTE OSTEOMYELITIS

Treated in

SURGICAL WARDS 7 & 8

of the

EDINBURGH ROYAL INFIRMARY.
CASE I.

J.T.  
Age 14 years.  Pit-head worker.  

COMPLAINT: Pain in left hip.

DURATION: Four days.

HISTORY: Four days before admission this boy began to complain of pain in the region of the left hip. He continued to work throughout that day, but on the following day he felt unable to carry on any longer because of the intense pain, so he returned home. At this time he experienced a certain amount of pain down the outer side of the left thigh and in the left knee. There was no sickness or vomiting, but since returning home from work the boy felt ill, had a few attacks of delirium, and the temperature had remained at 103°.

There were a few acne like pustules in face region and on back of the neck, which had but recently made an appearance.

There was no history of injury or recent accident which could be recalled by the patient.
PHYSICAL EXAMINATION:

The patient is a well nourished boy who appears flushed and very ill. The temperature is 103°.

The Tongue - Covered with a brown fur.
Teeth - A few teeth are carious.

Local Examination.

Left leg. Inspection: The patient lies with his left hip fully extended and a slight fullness is visible over the dorsum ilii. There is no sign of previous septic injury on the leg.

Palpation: There is marked tenderness over the dorsum ilii just below the crest two to three inches behind the anterior superior spine, and in this area there is slight swelling.

No tenderness can be elicited by pressure over the hip joint, along the line of the femur or in the knee joint.

Movements: All movements at the hip are free and painless, and movements at the knee are similarly normal.

Abdomen. Inspection: Nil abnormal to note.

Palpation: A certain degree of tenderness can be elicited in the left iliac fossa close to the iliac crest.
Circulatory and other systems - Nil abnormal detected.

DIAGNOSIS: Acute osteomyelitis of left ilium.

OPERATION: Performed on 6th November 1931. Anaesthetic used was Ethyl Chloride and Ether.

An incision five inches long was made just below the crest of the ilium on the left side from the anterior superior spine in a backward direction. The gluteal muscles were reflected from the dorsum ili and the bone exposed. There was found to be a considerable collection of sub-periosteal pus which was evacuated when the periosteum was incised. The bone over a large area of the dorsum ili was removed with a gouge; pus being found inside the bone.

The inner table was perforated and a small collection of pus found on the inner aspect. The wide area of bone thus exposed was packed with a flavine pack, and the wound edges approximated round it.

After the operation 50 ccs. of Anti-staphylococcal serum was given intra-venously.

PROGRESS: The patient was given staphylococcal serum intravenously each day following the operation: the total amount given being:

60 ccs. of concentrated serum and
80 ccs. of unconcentrated serum.
Two days after the operation the temperature was still elevated and there was a marked increase in the respiratory rate. A considerable amount of secretion collected in the bronchial tubes and accordingly he was given atropine gr. 1/100 four hourly during the next ten days.

He went slowly down hill but appeared to be making a good fight against the infection.

The local wound continued to discharge freely, but there was no evidence at any time of any formation of secondary abscesses.

On the 16/11/31 there was a great change in his condition for the worse. He became very much weaker and the delirium which had been present ever since the operation became less marked, the patient almost becoming comatose.

The weakness was progressive. A blood transfusion was administered but the pulse continued to be of a poor thready nature and the respiratory rate gradually increased.

The patient put up a wonderful resistance to the disease and stimulants were given regularly, but the boy died early on the morning of the 18th November 1931.

RESULT: Death.
CASE II.

F.G. Age, 11 years.

Admitted 29/10/30.

COMPLAINT: Pain in left knee.

DURATION: One week.

HISTORY: This little girl had always been in good health and remained well until one week before admission, when she began to complain of stiffness in the left knee, which was present for two days. After this, she complained of pain over the front of the knee, which gradually got worse. She was up and about for the first three days, but took to bed three days before admission and has been unable to walk since then.

PREVIOUS HEALTH: There is nothing to note about the patient's previous health.

PHYSICAL EXAMINATION: The patient is well-built, and intelligent. She has a good colour.

The throat is healthy.

The tonsils are not unduly large.

Teeth: are healthy.
Local Examination.

Inspection: There is a slight degree of double genu valgum, more marked on the right side. The left leg below the knee is swollen and red. This redness extends over the upper two-thirds of the leg.

Palpation: There is a marked increase of local temperature of the left leg, most marked over the upper third. The leg is tender to touch and fluctuation can be elicited in the upper third. The tibia is tender in its upper two thirds, the tenderness being most marked in the distal half of the upper third. There is pain on movement of the left leg, but no limitation of movement of the knee-joint. (See Figs. 21 and 22.) There is no tenderness over the left femur.

There is no evidence of any other focus of infection in the leg or in the remainder of the body.

Circulatory and other Systems:

Nothing abnormal was detected.

DIAGNOSIS: Acute osteomyelitis of tibia, left.
OPERATION: Performed on 29th October, 1930.

The anaesthetics used were Chloroform and Ether.

A longitudinal incision was made over the medial aspect of the upper end of the left tibia. Pus was immediately evacuated. The bone was exposed, the periosteum elevated, and pus found oozing through the bone. The affected portion of bone was gouged and chiselled away, and a rubber-dam drain was inserted down to the bone. The wound was closed with silk-worm gut. The operation was described as "Incision and Drainage."

The culture from the pus showed a pure growth of Staphylococcus Aureus.

OPERATION: Performed on 8th November, 1930.

The anaesthetics used were Chloroform and Ether.

The original wound was investigated and the bone excavated more deeply. Gauze was then packed into the wound and no stitches inserted. This operation was described as a "Curettage of the tibia."
PROGRESS: The patient remained well and the wound discharged freely until the 15th November, 1930, when the temperature suddenly rose to 104.6 and the patient became delirious, and complained of pain over the left knee-joint.

On examination, there was marked swelling of the knee-joint and fluctuation was elicited both on the medial and lateral sides. There was tenderness all over the knee, most marked on the medial aspect.

TREATMENT: Carried out on 15th November, 1930.

The anaesthetics used were Ethyl Chloride and Ether.

A wide-bore needle was inserted into the prepatellar pouch and 25 ccs. of pus were withdrawn from the knee-joint.

This treatment was described as "Aspiration of the knee-joint, left."

OPERATION: Performed on 22nd November, 1930.

The anaesthetics used were Ethyl Chloride and Ether.

The left suprapatellar pouch was aspirated and a quantity of thickish blood-stained fluid was obtained. An incision was accordingly
made on the lateral side of the patella, and a fairly large quantity of thick, blood-stained pus expelled from the knee joint. The joint-cavity was then syringed out with ether, and the wound closed with silk-worm gut sutures. A small strip of rubber-dam was inserted through the wound superficially.

The wound in the leg was then exposed and on inspection, a considerable portion of the shaft of the tibia was found to be necrotic. The diseased segment was therefore resected by means of a Ferguson's saw and the cavity packed with gauze. Dressings were applied, and the limb was placed in a posterior splint with the foot held in good position.

This operation was described thus:
"Incision and drainage of knee, left; Resection of portion of tibia, left." (See page 109.)

**OPERATION:** Performed on 13th December 1930.

The anaesthetics used were Chloroform and Ether.

The left leg was put up in plaster with slight flexion at the knee and dorsiflexion of the foot.

**PROGRESS:** On the 29th December, 1930, the plaster was bi-valved.
TREATMENT: Carried out on 30th December, 1930. The anaesthetics used were Chloroform and Ether.

The limb was extended from the flexed attitude and encased in plaster, the plaster extending to above the knee.

The treatment thus carried out was described as "Manipulation and plaster."

PROGRESS: A week after the application of the plaster, the temperature fell below normal and thereafter remained below normal till discharge.

DISCHARGED: The patient was discharged on 27.1.31 to the Convalescent Home, with the general condition and the local condition satisfactory and with the limb in comfortably-fitting plaster. She reported in March, and she continued to report to the hospital every month. In April, the plaster was removed, the wound was almost healed, and she was treated with massage. By June, she was walking wonderfully well with her caliper-splint, though the leg was, of course, still a little weak.

The child paid her last visit to the hospital on the 7th October, 1931. Her wounds were healed, and she was given permission to gradually leave off her caliper-splint. A report obtained a few days ago, stated that the little girl is in good condition and walks well.

RESULT: Preservation of the limb.
CASE III.

G.W.  Age 12 years.  Admitted 9/10/31.

COMPLAINT:  Pain on inner side of left leg.

DURATION:  Four days.

HISTORY:  Over a month ago patient received an injury to his left knee.  The skin was bruised and went a little septic.  There was no serious complication until four days before admission when he complained of pain in the left hip and groin and a limb developed.  He went to school on the following day but was sent home because the pain had become much worse.

On the day before admission his temperature was 104.5° and he had intense pain when the limb was moved.

On admission, patient is complaining of very acute pain in the left leg radiating down the medial side to the knee.

PHYSICAL EXAMINATION:  Patient is a fairly healthy-looking, well-developed boy.  He looks fevered and flushed and is obviously in pain.

Local Examination:

Left hip.  Inspection:  The hip is flexed and abducted.
Palpation: There is marked tenderness all round the leg and down the medial side of the leg. Pressure over the joint posteriorly does not elicit tenderness.

Movement: Movement of the leg is painful and the muscles round the joint are very rigid. Measurement of thigh shows a difference of one-half inch in the circumference as compared with the sound limb.

The tongue is somewhat furred.
No balanitis is present.

Abdomen: There is no abdominal tenderness.

Circulatory and other Systems: Nil abnormal detected.

DIAGNOSIS: Osteomyelitis, left femur.

OPERATION: Performed on 9th October 1931.

Anaesthetic used was Ethyl Chloride and Ether.

An incision was made on the outer aspect of the left thigh and the femur exposed. A hole was drilled into the medullary cavity and pus found to flow. Holes were then drilled at \( \frac{1}{2} \)" intervals right down the whole length of the shaft of the femur until at the lower end no pus flowed.

A large flavine pack was inserted and the skin edges approximated over it. "Starr's operation, left femur".
PROGRESS: The patient was given 30 ccs. of Anti-Streptococcal serum and was treated for shock.

Two days after the operation, under ethyl-chlor and other anaesthesia, two or three stitches were cut and the pack removed.

On 12/10/31 the patient was given 300 ccs. of blood from a donor, who had been previously immunised with 200,000,000 staphylococcal toxin.

19/10/31. Abscesses had developed on the outer side of the left ankle, the upper surface of the left shoulder and all over the back of the head. Under Gas and Oxygen the abscess on the shoulder was opened and a quantity of purulent material obtained. An incision was also made down to the pericranium, 2" behind the mastoid process on the left side, and a large quantity of extremely foul-smelling blood was evacuated.

On return to bed, the patient was very weak, and in spite of stimulant treatment, died in the late afternoon of the 19th October as a result of the very serious toxaemia.

RESULT: Death.
CASE IV.

D.S. Age, 7 years.

Admitted 8/1/31.

COMPLAINT: Pain and swelling in right leg.

DURATION: Two months.

HISTORY: Two months before, on the 3rd November, 1930, this little boy suddenly developed acute pain in the right leg. He also noticed some swelling, but not much redness. He was taken to hospital, where the swelling was incised, and he was recovering from this very well when, ten days later, he developed measles. Since then, the leg condition has remained almost stationary, there being no pain in the leg but some constant discharge. The patient has been in bed since 3rd November, 1930.

Two days before the swelling first appeared, the patient had sustained a severe kick on his right shin. It was badly bruised, but the skin was not broken. (See page 53, Trauma.)

The patient is very susceptible to colds.

PREVIOUS HEALTH: The child had measles when he was six years old.

FAMILY HISTORY: There is nothing to note in the family history.
PHYSICAL EXAMINATION:

Patient is a thin, pale little boy, not very alert mentally.

Tongue is moist and slightly furred.

Teeth are good.

Local Examination.

Right leg. Inspection: Over the anterior surface of the lower third of the tibia is an area of granulation tissue, from which some greenish-yellow discharge is exuding. Postero-laterally over this area of the tibia, a red, glazed area is apparent. There is thickening of the tibia. There is some degree of pes cavus.

Palpation: There is no tenderness elicited over any area. Fluctuation can be detected over the glazed area postero-laterally.

Circulatory and other Systems.

Nothing abnormal was detected.

DIAGNOSIS: Chronic osteomyelitis, right tibia.

OPERATION: Performed 13th January, 1931.

The anaesthetics used were Chloroform and Ether.

A vertical incision was made on the medial aspect of the distal end of the right tibia.
The deep fascia was divided, the periosteum was removed from the bone and with a gouge the bone was opened. A sequestrum was removed from the interior, as well as pus and some necrotic material. As much of the affected bone as possible was removed, the cavity was swabbed with BIPP and packed with vaseline gauze, and a silk-worm-gut suture inserted at each extremity of the wound. The limb was then encased in plaster, the plaster extending up to but not including the knee. The operation thus performed may be described as "Sequestrectomy, with removal of necrotic material and pus from right tibia, (Orr's method)." (See page 106)

A pure growth of Staphylococcus Aureus was obtained on culture.

**DISCHARGED:** The patient was discharged to the Convalescent Home, with the limb in plaster, on the 23rd January 1931.

There had been a rise of temperature three days after the operation, but this soon subsided and thereafter remained below normal.

**RE-ADMITTED:** The patient was re-admitted to hospital with the limb in plaster, on the 27th February 1931.

**PROGRESS:** The plaster was removed and the limb X-rayed. The wound appeared to be comparatively healthy.

**TREATMENT:** Carried out on 3rd March, 1931.
The anaesthetics used were Chloroform and Ether. The pack was removed from the wound, which was in a satisfactory condition, and a further vaseline pack was inserted.

On the 6th March, 1931, the limb was encased in plaster extending up to the knee.

**DISCHARGED:**

The patient was discharged on the 16th March, 1931, with the limb in plaster, the plaster to remain on for a period of six weeks. Thereafter, simple dressings were prescribed.

**RESULT:** The case is described as 'Cured', as since last reporting the little boy has continued to keep well, and the wound healed perfectly.
CASE V.

Mrs. G.E.       Age, 30 years.

Admitted 8/7/31.

COMPLAINT: The patient met with an accident the day of admission.

HISTORY: When she was walking along the road on the day of admission, the patient slipped off the pavement and fell, her left foot going under her. On trying to get up, she found that she could not move her left leg.

PHYSICAL EXAMINATION: The patient is a healthy-looking woman.

Local Examination: Left leg: There is marked swelling over the left thigh just above the knee where there is also marked tenderness. Active movements cannot be carried out without extreme pain. No other injury is detected.

DIAGNOSIS: Supracondylar fracture, left femur.

X-RAY EXAMINATION: X-ray examination revealed a supracondylar fracture of the left femur, with some displacement of the lower fragment.
**OPERATION:** Carried out on 8th July, 1931.

The anaesthetics used were Chloroform and Ether.

A Kirschner's wire was placed through the lower fragment and extension applied, the limb being put up in a Thomas's splint with knee-piece and suspended in a Balkan frame.

The operation was described as follows:

"Insertion of Kirschner's wire and extension".

**TREATMENT:** Carried out on 25th July 1931.

The anaesthetics used were Chloroform and Ether.

Before removal from the Ward and derangement of the extension, two Kirschner's wires were introduced from the medial to the lateral side in such a way as to transfix both fragments of the fracture. It was hoped by this means to prevent any disturbance of the position while the leg was being placed in plaster. The Thomas's splint and extension were thereafter removed and the limb put in plaster, the position at the conclusion of this procedure appearing to be satisfactory.

This treatment is described as "Application of plaster". 
**PROGRESS:** On the 31st July, 1931, the plaster was trimmed. The patient was described as progressing satisfactorily.

On the 3rd August, 1931, she was discharged in plaster, with the Kirschner's wire still in, and with instructions to report again at hospital.

**RE-ADMITTED:**

On the 19th September, 1931, the patient was re-admitted to hospital, suffering from severe pain in the left knee. It was decided to remove the plaster.

**TREATMENT:** The plaster was removed and the Kirschner's wire withdrawn.

It was found that patient was suffering from osteomyelitis of the femur.

Another plaster was applied and a large window cut on each side.

**PROGRESS:** Following the operation, the patient complained of considerable pain in the lower end of the femur. There was some swelling noted.

On the 29th September, 1931, considerable discharge escaped through the tissues on both sides of the lower end of the femur.
In view of the fact that the discharge from the sinus was not clearing up, on 4th October, 1931, the section of plaster between the windows over the front of the thigh was removed and hot fomentations applied.

On 5th October, 1931, the complete plaster was removed.

For the last few days up to 28th October, the patient's temperature was swinging from 99 to 103°. She complained of very little discomfort in the leg, but the limb around the knee was extremely hot and inflamed-looking. The knee and the leg were very oedematous, and on 24th October, an attempt was made to aspirate the knee-joint, but no fluid was obtained.

In view of the fact that the X-ray examination showed an infection of the knee-joint, it was decided to open the joint.

**OPERATION:** Performed on 29th October, 1931.

The anaesthetics given were Chloroform and Ether.

An incision 3" long was made on the lateral side of the knee-joint and some blood-stained fluid obtained. The incision was partially closed over a rubber-dam drain.

The operation was described as "Incision and drainage."
OPERATION: Performed on 31st October, 1931.

The anaesthetics given were Chloroform and Ether.

A 5" incision was made on the outer aspect of the left knee-joint. The muscles were dissected back and the lower end of the femur exposed. A sequestrum was found in the bone and this was excised. The cavity was scraped and the wound closed loosely. A plaster of Paris case was applied to the limb from the foot to the costal margin, a window being cut over the outer aspect of the knee-joint.

This operation was described as "Sequestrectomy, left femur, and application of plaster."

PROGRESS: Following the operation, the patient made a fair recovery. Her general condition improved somewhat and the limb was comfortable in the plaster. In the course of the week, however, she began to develop pain on the outer aspect of the knee-joint where there was a discharging sinus, and accordingly a window in the plaster was enlarged and another cut on the medial side of the knee-joint for the same purpose. This wound continued to discharge freely, but the patient's condition remained satisfactory.

On 19th December, 1931, the plaster was bi-valved and the anterior shell removed. This gave considerable relief, because the thigh
was so swollen and there was a fair degree of tension under the plaster. The sinus continued to discharge.

About the 28th December, 1931, the patient began to go slightly downhill. She became steadily thinner, her appetite was lost and she was not sleeping so well. In addition, her temperature was swinging rather more violently as this decline continued, until 3rd January, 1932, when it was decided to carry out an amputation. (See page 119, Amputation.)

On 4th January, 1932, the patient was given 500 ccs. of fresh citrated blood intravenously, and she showed a good reaction to the transfusion.

**OPERATION:** Performed 5th January, 1932.

The anaesthetics given were gas and oxygen.

A tourniquet was applied to the leg.

An incision was made over the anterior half of the thigh at the junction of the upper and middle thirds, and the ends were connected by vertical incisions, one on the medial and one on the lateral side.

At a point somewhat distal to the anterior incision, an incision was made round the posterior half of the limb, joining the ends of
the two vertical incisions. On opening through the deep fascia on the antero-lateral aspect of the limb, a large pocket of pus was opened into. The contents were evacuated. Dissection was continued down to the femur, the femoral vessels being clamped and tied. The femur was then cut across at a point some distance above the distal end of the flaps. The posterior flap was then cut through and the limb removed. The tourniquet was slackened, and the bleeding points controlled. At this time, the whole wound and throughout the abscess-cavity were liberally swabbed with acriflavine solution, and the anterior and posterior flaps were thereafter united with interrupted silk-worm-gut stitches, a drain being inserted into the abscess-cavity.

The patient was given subcutaneous saline before she was removed from the theatre. Post-operative shock was very considerable. "Amputation of femur with anterior and posterior flaps."

**PROGRESS:** The patient remained practically unconscious and extremely shocked after the operation. Attempts were made to revive her by means of stimulants, but her breathing gradually decreased in intensity and the pulse disappeared. She died about five hours after the operation, on 5th January, 1932.

**RESULT:** Death.
CASE VI.

J.H. Age, 16 years. Garden-boy.

Admitted 13th May, 1931.

COMPLAINT: Pain in right hip.

DURATION: Two days.

HISTORY: Two days before admission, the boy was seized with sudden pain in the region of the left buttock. A swelling developed, and the area became tender to touch. Since that time, the patient has been feverish, with profuse sweating, and he has been unable to sleep. His appetite, which was previously good, has become poor.

PREVIOUS HEALTH: Except for an attack of scarlet fever, the patient's health has been good.

PHYSICAL EXAMINATION: The patient is a well-nourished youth. On admission, he looks flushed.

Local Examination:

Buttocks: Inspection: There is slight reddening of the buttocks, more marked on the right side, accompanied by some slight swelling.

Palpation: There is extreme tenderness over the region of the right sacro-iliac joint, but also extending on to the left side.
Movements: The movements of both hip-joints are free and painless.

Abdomen: There is some tenderness in the right iliac fossa. Otherwise there is nothing to note.

W.B.C. 9,000.

Examination of the patient was otherwise negative.

DIAGNOSIS: ? Sacro-iliac disease, right.

OPERATION: Performed on 15th May, 1931.

The anaesthetics used were Chloroform and Ether.

An incision was made over the right ischial tuberosity; the muscles were separated and the ischial tuberosity exposed. No infection was found in that region.

Another incision was made over the region of the sacro-iliac joint. The ilium was exposed and the bone gouged out over the region of the sacro-iliac joint, but again no infection was found. The wounds were closed with catgut and silk-worm-gut.

The operation was described as an "Exploratory Incision".
PROGRESS: After the operation, the patient still complained of pain in the right buttock, but nothing further was discovered until three days later when the wound began to discharge some pus. After discharging fairly freely for a few days, the wound again dried up. The temperature still remained high, and it was accordingly decided to institute drainage by the anterior route.

OPERATION: Performed on 29th May, 1931.

The anaesthetics used were Chloroform and Ether.

An incision was made in the right iliac fossa, parallel to the gridiron incision and close to the superior iliac spine. On opening the wound, a large collection of pus was found extra-peritoneally, apparently arising from the diseased ilium. The pus was evacuated as far as possible and a rubber-dam drain was inserted, the wound being closed with silk-worm-gut.

The operation performed was described as "Incision and Drainage". The pus showed a pure growth of Staphylococcus Aureus.

PROGRESS: A small abscess developed over the right buttock.
OPERATION: Performed on 19th June, 1931.

The anaesthetics used were Chloroform and Ether.

An incision was made over the apex of the swelling and the contents of the abscess evacuated. A probe was pushed downwards to the lowest limit of the abscess-cavity and the point cut down upon, a rubber-dam drain being then inserted between the two openings.

This operation was described as "Counter-drainage."

PROGRESS: Notes of the patient's progress are given under the following dates:

On the 1st July, 1931, the wounds continue to discharge freely, but the patient remains very well and strength is being gained.

On the 30th July, 1931, there is now very little discharge from the wounds, and healing appears to be progressing satisfactorily.

On the 31st July, 1931, the patient was discharged to the Convalescent Home, pronounced 'Cured'.

On the 14th August, 1931, the patient reported, and his wounds were found to be healed and healthy.

On the 9th September, he again reported and the X-ray, which was then taken, showed a very satisfactory state of affairs. Permission was given for the boy to resume work in October, 1931.
COMMENTARY.
INTRODUCTION.

Acute inflammatory infection of the bones continues to be a subject of great practical importance. A generation ago Cases of this type of disease were familiar everyday occurrences to the general Surgeon. Now, however, they are not so frequent.

This diminished frequency may be due in part to the hygienic improvement in and greater care of the health and well-being of the child of school age - that age of "growing bones" and childish rompings which lead to the inevitable knocks and traumata on the school playground. The removal of carious teeth and prompt attention to inflamed tonsils and other septic foci, appear to play an important role in the diminished incidence of acute osteomyelitis.

It is rapidly becoming a rare disease, and is now 90% less than it was 20 years ago. Increasing facilities for cleansing the skin are now available for the general populace, and the adequate use of soap and water is aiding appreciably the eradication of the disease.
As acute infective osteomyelitis is accompanied by such severe constitutional disturbance - the case frequently comes under the notice of a physician. When diagnosed, a surgeon should be called in at once, to consider the advisability of free incision, drainage and other surgical measures.
HISTORICAL.

The first experimental attempt to discover the nature of osteomyelitis was made by Rosenbach in 1878. He allowed all sorts of physical and chemical irritants to act on the bone marrow, finally arriving at the conclusion that bone marrow phlegmon could be produced by no kind of irritant except of infectious origin. He was also the first to obtain an osteomyelitis of haematogenous origin. Shortly after this date, Kocher became interested in the subject, and the experiments of Rosenbach were confirmed by him.

Rosenbach cultured osteomyelitis pus, and with pure cultures of staphylococcus at hand he was able to produce osteomyelitis experimentally.

Since then much work has been done on this subject. Kraske maintained from his experiments that pus organisms may pass into the blood from tonsils or respiratory organs. Kocher demonstrated the importance of the intestinal canal and the genito-urinary tract has been implicated in the causation of osteomyelitis. Warren wrote at length on the etiological importance of excoriations, bruises, or small wounds in the skin.
DEFINITION of the DISEASE

Acute osteomyelitis is the result of an acute pyogenic infection localised in its early stages to the metaphysis of the bone. It is a disease of youth and the affection is essentially one of an age at which there are still unfused epiphyses. The term "schoolboy's disease" is metaphorically descriptive of the usual age and sex of the victim.

It is really a mistake to consider periostitis and osteomyelitis as separate diseases. They are the only really acute bone diseases.
Some Considerations of Structure of Osseous Tissue in Relation to Disease.

THE DEVELOPMENT OF BONE.

GROSS ANATOMY OF BONE.

Structural Divisions of Growing Bone.
Vascular Supply of Bone.

HISTOLOGY OF BONE - Structure.

The Marrow -
Macroscopic.
Microscopic.

The Periosteum.

IMPORTANCE OF METAAPHYSIS IN OSTEOMYELITIS.
Fig. 1. Illustrating commencing ossification of bone.
The DEVELOPMENT of BONE.

Bone is a variety of connective tissue, mesodermal in origin, which forms the supportive structure of the animal organism. It is the hardest substance, next to enamel, found in the vertebrata, and is noted for its toughness and rigidity.

True bone is formed in all cases by ossification of connective tissue. Bone formation is generally preceded by cartilage, in which there is, at first, a deposition of lime salts; an invasion then takes place, and for the most part this calcium deposit is removed by an embryonic connective tissue which re-deposits bony matter in the interior of the cartilage. (See Fig.1.)

This is called intra-cartilagenous ossification in contra-distinction to the other mode of ossification which is altogether unconnected with any cartilagenous formation and which takes place in such bones as the tabular bones of the skull, i.e. intra-membranous ossification.

The minute details of the development of bone are somewhat irrelevant to the matter under discussion; however, there is one stage in the life history of bone which is both pertinent and significant, that is -
Fig. 2. Longitudinal section through femur to illustrate the relationships of the various parts—epiphysis, epiphyseal cartilage, metaphysis and diaphysis are shown.

Fig. 3. Section showing Normal Metaphysis.
The Stage of VASCULARISATION.

Into the embryonic cartilaginous tissue blood vessels penetrate. The point at which they enter the shaft of a bone becomes the nutrient foramen.

The epiphyseal ends of the bone are invaded by vessels which pass through small epiphyseal canals.

The importance of the vascularisation of bone is discussed in the appropriate section.

GROSS ANATOMY of Bone.

Structural Divisions of GROWING BONE.

There are four main regions into which a typical long bone is divided, and the following terms are applied to them. (See Fig. 2.)

(1) A shaft or diaphysis, the extremities of which are -

(2) Epiphyses. Between the diaphysis and the epiphysis of a growing bone there intervenes the

(3) Epiphyseal Cartilage. Where the cartilage meets the diaphysis is the

(4) Metaphysis. (See Fig. 3.)
Fig. 4. Illustrating the Vascular Supply of Bone.
The **Diaphysis** or shaft is a cylinder of compact bone enclosing the medullary canal which is filled with yellow marrow.

The **Metaphysis** is of outstanding importance in the pathology of Osteomyelitis. It is composed of vascular spongy bone - the spaces filled with red marrow. It is the area in which activity is manifest as long as growth continues, and in which much of the pathology of bone arises.

**The VASCULAR SUPPLY of BONE.**

There is a definite relationship between the arrangement of the blood supply to bone and the occurrence of the different types of diseases in bone.

Lexer tracked the course of the blood vessels in bone, after injection, by a series of X-ray photographs.

The nutrient artery enters the shaft via the nutrient foramen (from the knee and towards the elbow is the scheme of distribution of nutrient vessels), bifurcates, and a main branch runs in the direction of the metaphyses. These arteries become very small through branching, and, after looping just back to the cartilage line, eventually end in a large venous capillary that runs towards the medulla. (See Fig. 4.)
Fig. 5. Illustrating the Vascular Supply of Bone.
HOBO - studied the blood vessel arrangement in bone, and when he injected very finely ground Chinese ink into the blood vessels of animals, the particles were found evenly distributed throughout the medulla. and the number of particles was strikingly less in the metaphysis than in the medulla. He believes, and attempts to prove, that the medulla is much richer in phagocytic elements than the metaphysis.

In the peri-synovial tissue of an adjacent joint there is the circus vasculosis from which come two sets of vessels, i.e.

(1) the Metaphyseal (juxta-epiphyseal) and (2) the Epiphyseal. (See Fig. 5.)

There are also numerous Periosteal blood vessels which penetrate the Haversian canals to anastomose with those derived from the main nutrient artery. The nutrient, juxta-epiphyseal and epiphyseal vessels ultimately anastomose in the metaphysis.

The veins of the marrow are large and are devoid of valves.

The nerves to bone and bone marrow accompany the arteries. They transmit sensory impulses (e.g. pain in disease) and exercise a degree of control over the blood vessels.
Fig. 6. Photograph of transverse section of compact bone, made by grinding, showing three Haversian canals with their concentric lamelle, and also Inter-Haversian bony substance. Magnified 200 diameters.

Fig. 7. Photograph of a Volkmann's canal piercing the cortical bone.
HISTOLOGY of BONE.

Only brief mention need be made of this subject. It is out of place to set forth the details and minutiae of all the histological features of bone, but let us allude to one or two points of importance in the minute structure of osseous tissue.

Bone is said to be compact or cancellous according to the degree of interspaces in its structure. (See Fig. 6.)

True bone is made up of lamellae which are composed of fine fibres lying in a calcified ground substance. Between the lamellae are branched cells, the bone corpuscles, which lie in cell spaces or lacunae. The ramified passages which contain the cell processes are termed canaliculi. (See Fig. 7)
Fig. 8. Photograph of longitudinal section of compact bone, showing Haversian systems of lamelle, and Inter-Haversian Bone. Magnified 200 diameters.

(a) Haversian canal cut longitudinally;
(b) junction of two Haversian systems of lamellae;
(c) margin of Haversian system abutting upon Inter-Haversian bone
(d) which has irregular lacunae.
BLOOD VESSELS.

(A) In cancellated bone the blood vessels run in the interstices supported by the marrow.

(B) In compact bone they are contained in little canals called Haversian Canals.

HAVERSIAN CANALS.

These small canals everywhere pervade the bone. They are from $\frac{1}{1000}$th to $\frac{1}{200}$th of an inch in diameter.

Most Haversian canals contain two small blood vessels, arterial and venous; nerve filaments and connective tissue.

In compact bone most of the lamellae are found disposed concentrically around the Haversian canals.

Volkmann's canals are simple canals for blood vessels which proceed from the periosteum to join the Haversian canals. (See Fig. 8.)

THE MARROW -

MACROSCOPIC considerations.

The bone marrow of the adult is of two
varieties, red and yellow. The red marrow is contained in the flat bones: the ribs, vertebrae, sternum and innominate bone. The marrow of the long bones, and also the small bones of the carpus and tarsus is yellow. But at birth and during the first few years of life, the marrow is a very different organ. For the first three or four years the long bones are entirely filled with active red marrow. On examining a long bone which has been bi-valved - the cut surface is pink, and juice of a rich colour can be expressed.

When a child reaches the age of seven or eight years, the marrow becomes of a more greasy texture, and the colour is less pink.

At this age microscopic fat can be demonstrated, and it is only at or about the time of puberty that macroscopic fat begins to appear in the middle of the shaft. Thus the marrow of a young bone is characterised by the small amount of fat cell content.

The central patch of fat extends steadily towards the extremities of a long bone, the red marrow becoming converted into the yellow variety, and by the age of twenty-one the metamorphosis is complete.
VASCULAR ARRANGEMENT of the MARROW

The blood supply of the marrow naturally depends entirely on its state of activity. It follows that the yellow marrow is very poorly supplied with blood, while the red marrow has an abundant supply. The red patch at the upper end of the femur and of the humerus is well vascularised. On the other hand there are no lymphatics in the marrow. Piney points out this fact in support of the theory of lymph spread of carcinomatous metastases from the breast to the upper end of the humerus and the femur.

MICROSCOPIC considerations.

The microscopic appearance of the marrow varies enormously, depending on whether it is the yellow or the red variety which is being examined.

The yellow marrow consists almost entirely of fat, in which may be found an occasional band of true marrow tissue containing a few nucleated red cells (normoblasts) and myelocytes. The red marrow also contains fat, but to a very much lesser degree. In the marrow of the healthy child lymphocytes are never seen.
The microscopical picture of the marrow of a young bone is characterised by the small number of fat cells seen, and the relatively large number of actual marrow cells, - granular, non-granular, and early types of red cell.

The cells of the blood (the erythrocytes certainly, and possibly the leucocytes) are formed from the vascular endothelium of the marrow.

**THE PERIOSTEUM**

is the limiting fibrous membrane which covers the bone. It consists of two layers, an outer fibrous in which the blood vessels run, and an inner cellular and osteo-genetic. The latter is really a potential space as the cells (osteoblasts) vary in number and activity according to the state of health or disease of the tissue.

The osteoblasts are continuous with those lining the Haversian Canals and the medullary cavity.

One of the main functions of the peristeme is to support the vessels going to be bone. Hence, if by a process of inflammatory exudation, the peristeme is stripped off at any part, there is great risk that the denuded portion of the bone will undergo necrosis and exfoliation.
CONCLUSIONS.

Importance of Metaphysis in Osteomyelitis.

There is a special vascular anastomosis at the growing end of a long bone, between the nutrient, epiphyseal and juxta-epiphyseal vessels.

It is the Metaphysis in a growing bone which has the best blood supply; therefore, blood borne infection finds a suitable nidus in this vascular area.

An important feature is the venous return. The slow flow of blood through the sinuses may permit of the deposition and consequent multiplication of organisms.

The region of the diaphyseal side of the epiphyseal line is perforated by the looping of blood vessels. This renders the area of the bone particularly liable to wrenching injuries, and the formation of haematomata.

Proximity to a joint leads to inter-association between diseases of the bone and the neighbouring joint.
The Incidence of Osteomyelitis.

Relationship to Age.

The disease is commonest between the third and tenth years of life, — the greatest incidence occurring at the sixth year. The explanation of this age incidence is to be found in the great activity which is taking place in the metaphysis-seal region at this age period.

The incidence of osteomyelitis diminishes with each successive year after the tenth year.

Relationship to Sex.

Boys are more liable to osteomyelitis than girls in the ratio of about six to one. The greater activity and increased exposure to trauma adequately explains this greater liability in boys.

Relationship to Social Status.

There appears to be agreement that osteomyelitis is more prevalent among the poor,
but it would be an error to suppose that it is limited to them, for very severe cases are met with in families far above the level of poverty. Such examples are comparatively uncommon, but definite enough to make it evident that lack of money and resources cannot be the only essential pre-disposing causes. Universal wealth, were it possible, could not be counted on to dispose of the disease altogether in the young. Nevertheless, its greater frequency among the children of the poor is sufficiently obvious to prompt repeated enquiry into the reason. It seems to me that the question is complicated, because it is easy to confuse pre-disposing causes which favour the initial attack of acute osteomyelitis with those which make the disease most intractable once it is established.

One would have hoped to obtain useful information from a study of the diet, and clear evidence of fundamental differences between the food of the poor and the well-to-do. In the cases under discussion, and from information derived from other cases, it can be stated with confidence that children in whom osteomyelitis occurs are not particularly those who suffer from lack of food. No evidence as to an hereditary predisposition was elicited from any of the cases under discussion.
To sum up in brief, it would appear at the moment that investigations do not seem to promise the discovery of any one outstanding predisposing cause, but rather a combination of many which tend to lower the general health.
ETIOLOGY.

BACTERIOLOGY of the Condition.

In 70% of cases staphylococcus pyogenes aureus is the infecting organism.

Other organisms which are met with are - staph-albus, pneumococcus, and rarely streptococcus. Pneumococcal osteomyelitis may occur primarily, but usually it is secondary to pneumonia or some such condition.

Cases have been reported of osteomyelitis due to B. Tyhosus. This complication develops about four to six weeks after the onset of Typhoid fever, but bone manifestations have become apparent in a few cases years after the typhoid had been cured. The disease usually manifests itself in the ribs and runs a comparatively mild course.

In America last year (1931), three cases of osteomyelitis, arising in connection with small-pox were reported.
The ORGANISMS in Acute OSTEOMYELITIS

<table>
<thead>
<tr>
<th>Organism</th>
<th>Cases</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staph. P. Aureus</td>
<td>421</td>
<td>70</td>
</tr>
<tr>
<td>Staph. P. Albus</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>Pneumococcus</td>
<td>130</td>
<td>22</td>
</tr>
<tr>
<td>Streptococcus</td>
<td>30</td>
<td>5</td>
</tr>
<tr>
<td>Bacillus Typhosus</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>600</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

This table shows the results of bacteriological examination in 600 cases, and indicates the relationship between the number of cases and different causal organisms.
The Source of Infection.

The infection reaches bone from some such source as (a) a boil.

"Staphylococcal fever", in which is included the immediate febrile consequences and the metastases of a boil or carbuncle, is more particularly a disease of children and young adults. In children, metastasis in bone leading to acute osteomyelitis is the usual sequel. In adults osteomyelitis is rare and perinephritis or the peri-nephric abscess is common. Metastases also occur in the prostate or in the muscle without serious pyaemic manifestations. In graver cases with septicaemia, multiple lung abscesses are common. The brain or a vertebra is a rarer site for a secondary abscess.

(b) septic teeth
(c) infected tonsils
(d) sinuses
(e) furunculosis
(f) pneumonia
(g) exanthemata
(h) umbilical sepsis.
Fig. 9. Showing abscesses in metaphysis and above line of cartilage in plate of epiphyseal bone are spaces filled with solid growth of staphylococci. Animal killed seven days after inoculation.
Weichselbaum showed, in patients who had no demonstrable blood infection, but who had died of pneumonia or erysipelas, the organism of the disease in the bone marrow. The conclusion therefore, can be come to that when there is contamination of the blood, the organisms are to be found in the medulla of bones.

The experimental production of osteomyelitis seems only possible in young animals.

Experimental work done in the Laboratory of the Experimental Research Committee of the University of Toronto leads to certain conclusions.

3 cc. of an emulsion of Staph-aureus made from a recent culture obtained from a case of acute osteomyelitis were injected into young rabbits. The following facts were derived from this work.

(1) Organisms introduced into the blood stream are deposited, among other places, in the long bones.

(2) In bone there is very active phagocytosis except in the metaphyses.

(3) Organism produces inflammatory centres in metaphysis independent of trauma. (See Fig. 9.)

(4) It is impossible to produce a general infection of the medulla by a simple inoculation of organisms into the blood stream.
Fig. 10. Showing metaphyseal abscess.
Further research work on this subject led D.E. Robertson of Toronto to come to the following conclusions.

(1) Staphylococcal infections come from skin lesions by contamination of the blood.

(2) The primary bone lesion in the human is determined by trauma.

(3) Continued septicaemia favours the formation of supplementary bone lesions.

(4) The bone lesion is in the metaphysis of a growing child. (See Fig. 10.)

(5) The chief symptom is pain; the chief sign — tenderness over the involved metaphysis.

(6) Treatment — early operation into the metaphysis for purpose of drainage.
The Site of the Disease.

The disease is especially common at
(1) the upper and lower ends of the tibia; and
(2) the lower end of the femur.

Any bone may be affected, and the order of frequency of bone involvement is found to be as in the table below.

The Bones Involved.

1. Tibia.
2. Femur.
3. Humerus.
4. Ulna and Radius.
5. Fibula.
6. Pelvis.
7. Vertebra, scapula, skull etc. - rare.
COLD and its relation to Etiology.

Acute osteomyelitis has been called "a disease of schoolboys", because it is at this age that the disease most frequently manifests itself. There is evidence which points to the fact that a possible predisposing cause is exposure to cold, for example, paddling in the sea when the water is at a fairly low temperature. The sequence of events might be as follows.

If the water is cold enough, or if the boy remains in the water too long - the circulation of the blood in newly formed and thin-walled blood-vessels escapes through the blood-vessel walls, and if there is a symptomless septicaemia, the organism use this haemorrhagic effusion as a culture medium and commence rapid multiplication and toxin formation.

It does not matter if the child now comes out of the water, dries his legs and re-establishes the circulation. The damage has been done. The organism which has settled down in the vascular metaphysis of the bone gives origin to the process of inflammation, and the characteristic sequence of events which typify the pathology of osteomyelitis.
Fig. 11.
Acute Osteomyelitis.
Fig. 11.

This illustrates a section through the upper extremity of a tibia.

The main features illustrated by this section are:

(1) The periosteum is separated from the surface of the bone.

(2) A surgical opening, communicating with the medulla, shows the recent exudation of lymph.

(3) On the cut surface of the cancellous bone of the upper end of the shaft, the metaphysis is of an intense red colour and is studded with areas of pus.

(4) The cancellous bone of the epiphysis shows no special change.

A Brief Clinical History of the Case.

The patient from whom this tibia was obtained was a boy, aged 13 years, who was admitted to Hospital acutely ill, and died from pyaemia a few days after operation.
SOME PATHOLOGICAL CONSIDERATIONS.

H. Brum and G.K. Rhodes discuss and emphasise the similarity of the underlying pathology of Acute Haematogenous (Metastatic) Perinephric Abscesses to that of acute haematogenous osteomyelitis. Both are apt to follow pyogenic skin infections, but whereas the former occurs in adults, the latter is almost invariably found in children. The reason for this is that pyogenic cocci, especially staphylococci, are in the child carried to the vascular bone marrow, which is undergoing great metabolic activity, and where the arteries in the metaphysis are end arteries. The perinephric fat in childhood is practically absent. In adults, on the other hand, the perinephric fat is well developed, and study of the arterial supply of the renal cortex and fatty capsules shows the arteries to be typical end arteries.

The Sequence of Events. (See Fig. 11.)

Primarily there is the focus of inflammation in the vascular metaphysis. The primary focus is almost without exception within the cancellous bone from which it spreads with variable rapidity and extent to the bone marrow and to the periosteum: finally, the infection may involve by
Fig. 12.
Acute Osteomyelitis.
Fig. 12.
Illustrating a longitudinal section of the lower end of a tibia.

The main features illustrated by this section are:–

(1) There is extensive suppuration in the interior of the shaft, both above and below the epiphysial cartilage.

(2) The epiphysial cartilage is partly destroyed and is perforated.

A Brief Clinical History of the Case.

This tibia is from a girl, aged 13 years, who was admitted to Hospital with a painful swelling of the leg of two days duration. Multiple abscesses appeared on the left ankle, limbs and neck. The leg was incised and the periosteum was seen to be separated from the shaft by a layer of pus. A considerable amount of pus was evacuated, from which Staphylococci were isolated. Death occurred two days later.
extension the intra-muscular planes, sub-cutaneous tissues and contiguous joints.

Let us discuss in more detail this spread from the inflammatory focus and trace the steps in the pathology of the condition.

There ensues an acute inflammatory process in the perivascular tissue.

The local pathological changes can be described as taking place in the following sequence.

1. (a) Congestive Phase (b) Phase of Pus Formation

2. Stage of Repair if patient survives.

Stage of Destruction - Naked eye Appearances.

The primary focus is a round patch of very oedematous marrow, and in most acute cases when the marrow is exposed, it is of a dull red colour and exudes drops of liquid fat. (See Fig. 12.)

Microscopically, the main feature is a great increase in the number of polymorpho-nuclear leucocytes in the marrow.

This - the Congestive Phase - is rapidly followed by Pus Formation. This pus is thick greenish and oily in nature, and at this stage
Fig. 13.
Acute Osteomyelitis.
Illustrating section of the right femur of a child.

The main features illustrated by this section are:

1. The shaft of the femur is acutely inflected.
2. Areas of pus and haemorrhage are scattered throughout the medulla.
3. The periopteous is separated from the bone, except at the epiphelial line and at the linea aspera.
4. The infection has resulted in separation of the great trochanter at its epiphelial line.

A CASE REPORT: FRACTURE OF THE FEMUR

This case was that of a boy, age 6 years, who was admitted to hospital complaining of severe pain in the right groin of three days duration. The pain radiated from the hip down to the knee.

On examination, the temperature was 103.1–104°F, the pulse 152, and the tongue was dry and brown. The right hip was hot and tender and its movements were limited and painful. There was no tenderness or oedema. An X-ray examination showed irregularity of the acetabulum, and of the head of the femur. Despite treatment the fever continued, and the patient died a few days later. At the post-mortem, a septicemia was found due to staphylococcal infection.
Fig. 13.

Illustrating portion of the right femur of a child.

The main features illustrated by this section are:

(1) The shaft of the femur is acutely inflamed.

(2) Areas of pus and haemorrhage are scattered throughout the medulla.

(3) The periosteum is separated from the bone, except at the epiphysial line and at the linea aspera.

(4) The infection has resulted in separation of the great trochanter at its epiphysial line.

A Brief Clinical History of the Case.

This femur was from a boy, age 6 years, who was admitted to Hospital complaining of severe pain in the right groin of three days duration. The pain radiated from the hip down to the knee.

On examination, the temperature was 103 – 104°, the pulse 132, and the tongue was dry and brown. The right hip was hot and swollen and its movements were limited and painful. There was no tenderness or oedema. An X-ray examination showed irregularity of the acetabulum, and of the head of the femur. Despite drainage the fever continued, and the patient died a fortnight later. At the post-mortem, a pyaemia was found due to staphylococcal infection.
Fig. 13a. Showing periosteal reaction in osteomyelitis of shaft of femur.
actually bathes the bone lamellae.

Owing to the confined space available, the pus resulting from the inflammation is formed under so much pressure that great pain, high temperature and great constitutional disturbance soon manifest themselves.

There is a destruction of blood vessels in the marrow by the pus and pressure. This may be so complete as totally to deprive the affected portion of the bone of its essential blood supply, and so induce necrotic changes, and the less resistant cancellous tissue dies.

The compact bone has a blood supply which is derived from the periosteal vessels, and maintains a resistance for a much longer period. If the disease attacks both extremities of the bone, the term Bi-polar osteomyelitis is used. The pus rapidly makes its way up and down the marrow cavity and also outwards through the bone, and collects under the periosteum. (See Fig. 13.)

The PERIOSTEAL Changes. (See Fig. 13a.)

The periosteum is :-

(1) at first thickened by inflammatory exudate;
Fig. 14.
Acute Osteomyelitis.
Illustrating the lower part of the left femur of a child, with some of the soft parts covering it. The bone has been divided by coronal section.

The main features illustrated by this section are:

1. Complete separation of the epiphysis, due to suppuration between the epiphysial cartilage and the diaphysis.
2. Suppuration has extended upwards beneath the periosteum, separating that membrane from the bone.
3. Small fragments only of the epiphysial cartilage remain.
4. The adjacent cancellous tissue of the shaft is ulcerated, most extensively in its inner part where irregular spaces in it are occupied by granulation tissue.
5. Just above the patellar surface of the femur is the mouth of a sinus which leads from the interval between epiphysis and shaft into the knee joint. The synovial membrane around its mouth is covered with granulation tissue, and a portion of the articular cartilage has been eroded.

A Brief Clinical History of the Case.

This patient was a girl, aged 9 years, who complained of pain and swelling of the left thigh three days before admission to Hospital. She had had a fall two days before the onset of the pain. On the eighth day, an abscess was opened above the medial condyle, and the lower part of the shaft of the femur was felt to be bare. Subsequently, pyaemic abscesses were opened in various parts of the body, and on the nineteenth day the lower epiphysis was found to be separated from the shaft.

The leg was amputated in the lower third of the thigh, and the patient left the hospital three months after admission with a sinus in the stump.
Fig. 14a. Osteomyelitis of lower end of femur showing reaction.
(2) later raised from the bone by the formation of pus between the two.

By being raised off the bone the periosteum is deprived of its supply and dies. The process of separation of the periosteum commences opposite the site of primary infection, and travels along the shaft at a rate somewhat slower than that of the medullary inflammation. Pressure of pus accelerates this process. (See Figs. 14 and 14a.)

Apart from the end of the bone affected by the disease, the remainder of the bone retains a partial periosteal covering; except in neglected cases, when complete denudation may take place.

Path of Pus from Periosteum to Body Surface.

The sub-periosteal abscess is inclined to burst through the attachments of the periosteum at the epiphyseal lines. An oedema is excited in the surrounding tissues followed by abscess formation.

If the patient survives the toxaemia, the pus from the bone may reach the body surface. It does not always take the shortest route, and is occasionally deflected by connective tissue planes.
Fig. 15. Chronic Osteomyelitis -

Showing sequestrum and new bone formation.
giving the appearance of

(1) arising from a neighbouring bone, and

(2) being caused by another disease: e.g.,
osteomyelitis of iliac crest with abscess in right iliac fossa may simulate appendicitis.

Pathology of Stage of Repair.

At any point the evolution of the disease may be interrupted by surgical interference; if not, and the patient survives and tension is released by the discharge of pus on the surface of the body certain events take place.

(1) The dead portion of bone - or Sequestrum - is separated by ulceration from the living bone in contact with it. It is lying in a cavity within the bone lined by granulation tissue. This sequestrum may in time be extruded to the surface by granulation tissue and increased tension. (See Fig. 15.)

(2) An Involucrum is formed, that is, a new sheath of bone is formed by the osteoblasts adherent to the periosteum - the function of this new boney cylinder being maintenance of continuity of the shaft.

(3) Cloacae are formed. These are openings through the rough and irregular walls of the
Fig. 16. Schematic representation of a long bone, showing directions of possible spread of infection from the metaphysis (para-epiphysial or juxta-epiphysial region).
involucrum, through which pus and inflammatory products in the interior escape towards the surface. A cloaca in an involucrum is the equivalent of a sinus in the soft parts.

**THEORIES in Reference to MODE of SPREAD of INFECTION from METAPHYSIS**

Much pathological investigation has been undertaken for the solution of this oft debated point.

It is generally believed that spread is from the primary focus in the juxta-epiphyseal region

(1) centrally to the medulla; and
(2) along the epiphyseal line to the cortex.

where a severe infection is produced under the periosteum with a serous effusion. (See Fig. 16.)

The infection may spread rapidly down the medullary cavity till the greater part or the whole of the shaft is involved. The periosteum shows a reaction, its blood vessels dilate and an effusion may lift the membrane off the bone. This separates the compact bone from its nutrient supply in the periosteal vessels and combined with the action of the toxins of the organisms, this portion of the shaft undergoes necroses.
According to C. Starr of Toronto, acute haematogenous osteomyelitis is almost confined to children in whom the epiphysis is not yet fused with the diaphysis.

He did a great deal of experimental work on osteomyelitis in dogs, and he maintains that invasion of the medullary cavity occurs late in the disease. (This is of great importance in considerations regarding surgical intervention). He also came to the conclusion that spread of infection into the epiphysis or into the joint was rare, this being due to the firm periosteal attachment to the epiphysis beyond the epiphyseal line.

Starr agrees that the commonest direction of spread is probably through the compact bone at its thinnest point where it joins the epiphysis, with subsequent formation of a sub-periosteal abcess. He insists that when medullary infection occurs it is by way of the Haversian canals from a subperiosteal abcess.
Fig. 17. Acute Osteomyelitis (Girl 9 years old).
Showing pathological fracture.
Complications arising by Local Spread of Infection.

1. Destruction of epiphyseal cartilage leading to involvement of the epiphysis may take place.

2. Infection of neighbouring joint by
   (a) perforation of articular cartilage, or by
   (b) extension of inflammation outside the bone without epiphyseal involvement.

   A common mode of spread is via the metaphyseal vessels especially in the femur. In the tibia the epiphyseal vessels are of greater importance than the metaphyseal, and spread to the joint is rare.

   The joint adjacent to an infected metaphysis frequently contains a "sympathetic effusion" which is purely of a serous nature and non-infective.

3. Pathological fracture is now a rare occurrence. (See Fig.17.)

4. At the lower end of the femur there is a possibility of secondary haemorrhage due to disease invading and opening into the popliteal artery.
GENERAL or SYSTEMIC COMPLICATIONS of OSTEOMYELITIS.

Acute suppurative osteomyelitis is of a profound septicaemic nature at its onset. The most important manifestations of systemic complications are:

(1) There is a great tendency to metastatic foci in other bones of a lower grade of virulence.

(2) Suppuration in joints and serous cavities. Endocarditis and pericarditis due to spread of infection through the blood stream. (See Case II.)

(3) Perinephritic abscess has been alluded to previously.

(4) In fatal cases petechial haemorrhages and thrombotic hemiplegia have been observed.

(5) Pyaemic abscess is common in lung, liver, brain, etc., and broncho-pneumonia is a pyaemic manifestation of grave importance. (See Case III.)

Cases have been reported in which complications such as Brodie's abscess have lain dormant, and shown clinical activity after the lapse of many years.
Fig. 18. Chronic Osteomyelitis (long standing)

Showing sequestrum at lower end of femur.
The PATHOLOGY of CHRONIC OSTEOMYELITIS.

Brief allusion to chronic osteomyelitis must be made as this condition is frequently a late complication of Acute Osteomyelitis, which may or may not have experienced surgical intervention.

I. This condition may be a sequel to an acute osteomyelitis which has been opened and drained and yet the wound lingers on for years. The wound may frequently heal but relapses occur soon after or perhaps years later.

II. It may represent a type of inflammation which differs from that of acute suppurative osteomyelitis only in the lesser virulence of the invading organism and in the correspondingly slight reaction of the bone to its activities.

In these chronic cases the affected bone usually contains either:

(1) a sequestrum, or
(2) a cavity. (See Figs. 18 and 19.)

There may or may not be a sinus.

One has seen a radiogram of a small sequestrum completely enclosed in a thick shell of dense bone.
Fig. 19. Trigone of femur.

Showing extensive erosion of bone in chronic osteomyelitis.
Fig. 20. Brodie's Abcess.
BRODIE'S ABCESS.

Brief reference to the condition known as BRODIE'S ABCESS is necessary to complete the description of the various manifestations of chronic osteomyelitis.

Brodie's abcess is not a true osteomyelitis. It is due to a mild infection by a relatively non-virulent staphylococci. The disease starts insidiously without an acute attack. It may occur at the extremity of any long bone, which in consequence becomes enlarged by the deposition of new subperiosteal bone. A cavity is formed in bone containing pus, enclosed in a densely sclerosed wall with a lining of granulation tissue. (See Fig. 20.)

It is a small abcess cavity situated frequently near the metaphysis and is especially common at one or other end of the tibia. The condition may go on for years without symptoms, apart from occasional local pain and occasional febrile manifestations.

After a period of quiescence extending often over many years, a sequence of exacerbations and remissions develops. It rarely heals of its own accord. X-ray examination shows a cavity
surrounded by a ring of sclerosed bone. This indicates reaction to septic infection, and aids in the differential diagnosis between Brodie’s abscess and Tuberculous disease or tumour of bone.
Some Rarer Forms of Osteomyelitis.

**Typhoid Osteomyelitis.**

This condition may occur at any time after the acute illness. The results of infection may become apparent during the later weeks of the disease, or only after the lapse of months or years. No age is exempt, but the condition is common in young subjects.

The sequence of events is:
1. Intestinal lesion
2. Blood stream
3. Costo-chondral lesions.

The cartilage is affected as frequently as the bone itself.

The disease rapidly spreads to the surface of the bone and secondary invading organisms may complicate the picture. True typhoid pus is rust-coloured and the cavity in the bone is lined by tuberculated masses.

The lesion is fairly localised with little periosteal reaction.
Serous Osteomyelitis.

This is a rare and rather mild form of the disease. The causative organisms are staphylococcus albus, pneumococci or streptococci.

The disease starts acutely and soon becomes chronic. A sub-periosteal effusion is set up, which consists not of pus - but of a serous or mucoid exudate.
CERTAIN CLINICAL CONSIDERATIONS.

Before going into a detailed analysis of the symptomatology of this condition, let us give a brief general description of a typical case, such as we are likely to encounter in the Surgical Outpatient Department of any Hospital.

A young boy is brought to Hospital complaining of a "sore leg".

Probably the first sign of there being anything amiss with the limb will be a complaint of aches or pains near a joint; and these pains are apt to be called rheumatic. Osteomyelitis is often mistaken at its onset and treated for acute rheumatism, even by skilled observers.

This is a serious matter, for osteomyelitis is so grave a disease, and is so apt to be complicated by septicaemia, that delay in its detection may cost the limb or the life of the patient.

Perhaps the pains occur during convalescence from scarlet or typhoid fever, or after exposure to injury or to wet or cold, or after unusual fatigue.

The part becomes swollen, hot, red and excessively tender: the tenderness, however, is not
in the skin, but in the bone and surrounding periosteum.

The temperature may run up to 104° and may be associated with convulsions or shiverings.

The patient's nights are disturbed, and very likely he has violent delirium in some cases.

If the case is allowed to drift on, abscess forms, and death may ensue from septic pneumonia or pericarditis, or from some other manifestations of spread of infection.

Osteomyelitis would appear to be on the wane. The term "acute" osteomyelitis, though it does not imply fever, is rather misleading, for it is now well recognised that many cases commence insidiously. Most, it is true, flare up and then become acute, but acquaintance with the earlier manifestations before that stage is of paramount importance. The term, therefore, "acute", which only comprises the acute phase of the disease, tends to lull earlier suspicions.
The Clinical History.

The history of the patient must be diligently and patiently investigated. There may be a history of boils, of a fever, a recent attack of sore throat or tonsilitis. There is usually some information obtainable regarding injury to the region while at play or by accident. Commonly an obscure history of ill-health. The onset, however, may be sudden, with absence of any introductory symptoms. Cases III and IV give a history of trauma, and sepsis was present in Case III. Scarlet fever in Case VI.

Symptomatology.

Local Symptoms. Pain of a very severe character and coming on suddenly. Stiffness and pain at site of trauma. These increase until loss of function occurs.

General Symptoms. There is a general reaction and the constitutional symptoms come on suddenly and are very marked. The temperature is elevated perhaps to 103° or 105°. By now the child is flushed and experiences nausea and may vomit. Restlessness and sleeplessness due to the pain are prominent features. The pulse tends to rise. Tongue and eye changes indicate absorption of toxin. There are generalised toxic manifestations and frequently a rigor or convulsion and great prostration.
The Slight Improvement.

About twelve hours after the onset of general symptoms there is a stage of improvement. This is due to the pus reaching the subperiosteal region.

Later general illness.

In a short space of time, however, the symptoms of pain and toxaemia recur with increased fervour due to an increasing tension under the periosteum. This stage, if it terminates fatally, is characterised by delirium, temperature increase and coma followed by death, as illustrated by Cases I and III.

METHOD of CLINICAL EXAMINATION of a CASE.

General Appearance.

The child is flushed, restless, extremely apprehensive in the early stages, but tends to become apathetic as the disease progresses and toxaemia becomes more evident.
Fig. 21. Testing local temperature in the case of the knee-joint. The hand is passed rapidly from the non-affected to the affected side and back again.

Fig. 22. Percussing the tibia for tenderness. A useful sign in the diagnosis of osteomyelitis.
Local Examination. 1. Inspection -

In early stages.

The contour of the part is usually normal but one must carefully compare the two sides to detect minor degrees of swelling. A blister may be observed with matter exuding, and there may be a furuncle. The skin may be red, abraded or oedematous. There is a certain constancy in the type of skin lesion produced by staphylococcus aureus.

2. Palpation -

(a) Test for localised heat (See Fig. 21.)

(b) Bone percussion to elicit tenderness (See Fig. 22.)

(c) Pressure over the bone and Points of Maximal tenderness. (vide infra.)

(d) Exclude arthritis - rheumatic and septic in which there is synovial involvement, remembering the possibility of "sympathetic effusion" into a neighbouring joint in acute bone inflammation.

An oedema develops, which becomes reddened. At first it is situated just over the focus of infection, but as the infection spreads in the subperiosteal space the oedema is observed to move from the joint towards the shaft. This is a late sign. The swelling under the periosteum and soft parts may occasionally be felt, especially in the tibia.
Fig. 23. (1) Maximal points of tenderness in early cases of osteomyelitis. Anterior aspect of upper extremity.

(2) Maximal points of tenderness in early cases of osteomyelitis. Posterior aspect of upper extremity.

(3) Sites of subperiosteal abscesses from osteomyelitis. Anterior aspect of upper extremity.

(4) Sites of subperiosteal abscesses from osteomyelitis. Posterior aspect of upper extremity.

Fig. 24. (5) Maximal points of tenderness in early cases of osteomyelitis. Anterior aspect of lower extremity.

(6) Maximal points of tenderness in early cases of osteomyelitis. Posterior aspect of lower extremity.

(7) Sites of subperiosteal abscesses from osteomyelitis. Anterior aspect of lower extremity.

(8) Sites of subperiosteal abscesses from osteomyelitis. Posterior aspect of lower extremity.

(9) Sites of subperiosteal abscesses from focus at the upper end of the tibia.
CONCERNING POINTS of MAXIMAL TENDERNESS.

(See Figs. 23 and 24.)

It is held that in every case there is to be found a very definite point of maximum tenderness on pressure over the affected bone. (Kennon)

These points usually correspond with the metaphysis which is mostly responsible for the growth of the bone - for example:

(1) antero-internal aspect of the neck of the humerus.

(2) anterior surface of the lower end of the radius.

(3) the post. aspect of the lower end of the femur.

(4) the antero-medial aspect of the upper end of the tibia.

The existence of this point of maximum tenderness is important from two points of view; firstly, it serves to distinguish the case from one of arthritis, and secondly, it indicates the position of the incision which should be made in the treatment of the case (vide infra.)
General Examination.

A very careful examination of the Cardiac and Respiratory Systems should be performed in order to detect early signs of heart involvement such as endocarditis or pericarditis, and to make certain that there is no pneumonia or other metastatic manifestations.

The Alimentary System should be thoroughly overhauled with special reference to the teeth, tonsils, gums, etc., in order to eliminate any septic foci discovered.

A blood count will show an increase in the polymorphonuclear leucocytes in most cases; but, occasionally in osteomyelitis the white count is low, and it may be high in rheumatism, therefore a diagnosis cannot be made on a White Cell count.
THE DIAGNOSIS.

Presumptive evidence of osteomyelitis is afforded by the age of the patient, by the history, and by the presence of one or more predisposing factors. (See Case III.)

The diagnosis is seldom in doubt clinically when there is intensity of local symptoms and evidence of a high degree of toxaemia. The earliest characteristic symptom of acute osteomyelitis is pain and tenderness on pressure with one finger over the end of a long bone - and this has been aptly described as "one-finger rheumatism of bone".

The femoral trigone may occasionally offer difficulty in diagnosis when swelling and redness do not appear in the early stages.

The few physical signs are diagnostic of the acute onset of osteomyelitis, and an early concise diagnosis and proper surgical treatment are of the greatest importance, as thereby much deformity and suffering and the ravages of chronic bone disease will be averted in most cases of moderate infection.
CONCERNING the VALUE of X-RAY in DIAGNOSIS

The chief point is that the early stages of the disease do not give rise to anything abnormal on the X-ray Film. An osteomyelitis has usually passed from the acute stage before the X-ray bone changes are visible. It is considered that six days at least must elapse from the acute onset before the X-ray signs can be found, and this negative X-ray evidence, inasmuch as it excludes other things, is in itself a valuable diagnostic point in a suspected case.

The fact that the X-ray picture is practically negative in the early stages of the disease is of very great importance, and it is quite wrong to be led by this negative finding to postpone operation.

Clinical methods are supremely important in the diagnosis of early cases of osteomyelitis.
THE DIFFERENTIAL DIAGNOSIS.

Osteomyelitis must be distinguished from:-

(1) **Acute Rheumatism** - polyarticular and interarticular
   
   (a) the pain in rheumatism is not so unremitting.
   
   (b) the history is different.
   
   (c) rheumatism is a non-septic arthritis.
   
   (d) the skin in rheumatism is moist - in early osteomyelitis it is dry.

   When a case that has been diagnosed as inflammatory rheumatism or rheumatic fever, presents an abscess, this case is one of osteomyelitis.

(2) **Cellulitis**.

   Here the intense degree of general illness is the differentiating factor. Pain and marked toxaemic manifestations are absent in cellulitis.

(3) **Early Tuberculosis** is situated in the epiphysis. The disease is insidious and temperature is less marked.

(4) **Scarlatina**.

   The diagnosis of acute osteomyelitis in
children is sometimes missed. A number of the patients die, and others present themselves in hospital with necrosis, involucrum and sinuses.

A surgeon was called to see a child of six years of age. The illness commenced with sore throat; a scarlatinaform rash, with high temperature, followed, and the diagnosis of scarlatina was made. Acute pain developed in the upper end of the tibia, but the symptoms of Scarlatina were so pronounced that the pain and tenderness in the tibia were overlooked until they became unbearable.

The real diagnosis was a septic sore throat with metastatic streptococcal infection of the upper juxta-epiphyseal extremity of the tibia. Operation was followed by complete cure.

The child developed Scarlatina eighteen months later during an epidemic.

Therefore the presence of a rash should not be misleading.

(5) Erythema Nodosum.

There are two main features of distinction between acute osteomyelitis and Erythema Nodosum.
(9) **Chloroma** - has been known to cause difficulty. It is a tumour under the periosteum which has a definite green colour.

(10) **Separation of Epiphysis** in Congenital Syphilis. This is characterised by pain and sudden onset, but there is no toxaemia.

(11) In **Haemophilia** there is no toxaemia.
THE PROGNOSIS

The prognosis of osteomyelitis is never favourable.

Factors influencing the prognosis.

(1) The Bacteriology of the condition.
   (a) Staphylococcus aureus infection has the most grave outlook.
   (b) Pneumococcal osteomyelitis is most favourable of all.
   (c) Streptococcal infections give extremely variable end results.

The important factor is that the prognosis is largely determined by the degree of septicaemia.

(2) Site of Lesion.

   There is a definite relationship between prognosis and proximity to trunk and skull contents. The more distal the focus the more favourable. It is said that the earlier the appearance of subperiosteal effusion the better the outlook.

(3) The Type of Patient.

   Such factors as age, general health,
cell body are stained, and, in severe cases, may be seen protruding from the cell envelope, i.e., the more marked the glycogenic response the more grave is the prognosis. This test is considered of little value and is rarely applied.

CAUSE of DEATH.

The virulence of the disease may be held accountable for a large number of deaths. And no doubt an acute osteomyelitis which invades a joint, and which is accompanied by a virulent staphylococcus bacteriaemia is often fatal; and an osteomyelitis that is intense, spreads rapidly, and is attended by profuse suppuration, will result in much tissue destruction and a more or less complete loss of joint function.

Generally, even in neglected cases, life can be saved, but it must be borne in mind that, in fulminating cases, septicaemia will cause death, however careful the operator may be to establish free drainage; further, with pyaemic cases there is an ever present danger of pericarditis.

(See Cases I, III and V.)
OSTEOMYELITIS of the VERTEBRA.

This disease is very uncommon, but as it is so rapidly fatal, and as one has noted an increasing number of cases reported in literature of recent date, it might be of interest to discuss in brief what is known of the condition.

The main obstacle is the supreme difficulty in diagnosis. In four cases discussed by H.W. Carson, the initial cause in three was the same - a boil - and in the fourth a boy had a subcutaneous abscess in the coccygeal region containing pus, giving a pure culture of Staphylococcus aureus; it is possible that this was a secondary abscess, the original focus not being apparent. A feature common to them all was an infection of the urinary tract. One patient lost his kidney from multiple abscesses. The boy had his kidney explored, and in the other two cases prostatitis occurred, one going on to abscess.

Many cases have now been recorded of acute osteomyelitis of the vertebra following certain specific infections - for example, typhoid fever, pneumonia, gonorrhoea, and rarely syphilis.
DIFFERENTIAL DIAGNOSIS:

The important differentiation is from tuberculous disease of the spine, and this is not difficult as a rule. Infective osteomyelitis of the spine affects adults more than children, is preceded by some disorder such as a boil (though it must be remembered that a trifling ailment like a boil may be overlooked or forgotten), pneumonia, or typhoid fever, and has a severe onset with high temperature and extreme prostration.

The three main symptoms of tuberculous disease are:—

(1) deformity
(2) cold abscess and
(3) paralysis,

of which deformity is usually the first sign.

In infective osteomyelitis, deformity is rare, owing to the buttressing of the weak spot by new bone. This is well seen in X-ray examination.

Pain, and especially lancinating pain, is characteristic of infective osteomyelitis, and is not relieved by rest as in POTT'S disease.
PROGNOSIS:

In the acute variety mortality is very heavy. The disease commences in the bodies or the laminae of the vertebra, and tends to infect the pleura and spinal meninges.

The condition is extremely dangerous, and in most cases is so rapidly fatal that operation is rarely carried out.

If abscess formation takes place, drainage is indicated. Psoas abscess and retro-pharyngeal abscess are relatively frequent complications.
CONCERNING TREATMENT.

INTRODUCTORY.

There are some cases in which the disease is chiefly a local infection of one bone, but in the majority the disease is from the outset a true septicaemia with one or more bone foci. Local foci of infection, such as diseased tonsils, or teeth, or sinus, should invariably be eliminated at once upon undertaking the treatment of patients suffering from osteomyelitis.

The first point of importance is to recognise these foci of bone infection, and to cut down upon them and freely drain both the subperiosteal and the marrow cavities, saving as much periosteum as possible. By this means life is saved in many cases, but the further conduct of the case must be determined by the fact that smooth healing may take place, or on the other hand sequestra may form and may have to be removed. The question of subsequent operative treatment depends upon many factors, particularly the adequacy of the drainage and the relations of the sequestrum.
METHODS of TREATMENT.

The whole aim of treatment in the early stages should be to cut the disease short before any extensive change has taken place in the bone, either of rarifaction or sequestrum formation. Certain fundamental principles underlie the various modes of surgical treatment advocated by different authorities.

Let us discuss these briefly. The main principles are:-

(1) The Establishment of Early and Effective Drainage

Drainage of the infected area at the earliest possible opportunity is essential. Surgical opinion appears to be agreed on that point.

(2) The second principle is prevention of extension of infection to unaffected areas, and conservation of the vascularity of the part to the greatest possible degree.

(3) The third principle consists of various methods of combating the systemic infection and the toxaemic manifestations which so frequently culminate in a fatal issue.
LOCAL TREATMENT.

The statement of R.A. Cutting, that: "Acute osteomyelitis is a surgical emergency as acute an emergency known to surgery - minutes count" - is accepted and acted upon by most surgeons.

There are many striking differences of opinion regarding the technique of the treatment and post-operative treatment of acute osteomyelitis, but general agreement prevails as regards the supreme importance and urgency of obtaining adequate drainage.

In the series of Cases under discussion the local treatment was as follows -

Case I. - Incision and Drainage.
Case II. - Diaphysectomy.
Case III. - Starr.
Case IV. - Orr.
Case V. - Amputation.
Case VI. - Incision and Drainage.

Let us discuss the various types of operation, and try to determine the relative value of each according to the results obtained in the above series of cases.
There are six main types of operation which may be performed. It seems to me that the choice between mere boring into the metaphysis, free "guttering", and mass resection, etc., must be left to the individual surgeon, as well as being influenced by the type of case with which the surgeon is dealing. In all cases, he should satisfy himself that the case is a suitable one for operation and not of the type in which delay is more advisable than immediate surgical interference. (FRASER) (See p.97)

The various forms of treatment advocated by the different surgeons are based upon their own conception as regards the pathology of osteomyelitis, and in particular in relation to their belief as to the mode of spread of infection from the primary metaphyseal focus to the sub-periosteal region and to the marrow of the shaft, for example, the rationale of the method of Starr is determined by his idea of the slowness of spread of infection from a sub-periosteal effusion through the Haversian canals into the marrow of the diaphysis. However, to those, who believe in a rapid spread from the primary focus directly to the marrow of the shaft, there is an indication for free guttering of the affected area.
TYPE of CASE

in which

IMMEDIATE OPERATION IS NOT INDICATED.

(FRASER)

This type of case occurs usually in very young children and there is generally a previous pneumococcal history.

CLINICAL FEATURES.

In general the temperature is not unduly raised as one finds in the average case.

The joint neighbouring the metaphysis affected usually shows a "sympathetic effusion" of a serous nature.

The toxaemic and febrile symptoms are slight.

BLOOD EXAMINATION.

The white count is not so high as in the other types of acute pyogenic osteomyelitis.

TREATMENT.

In this type of case no operation is performed until more definite signs of suppuration and toxaemia manifest themselves.
Briefly, the treatment consists of:-

(1) Fixation of the limb in the extended position.

(2) Application of local counter-irritants to the part affected.

(3) If the pain is of a severe nature, necessitating some form of sedative, the administration of Chloral and Bromide will prove to be most suitable and successful.

(4) Serum therapy has proved beneficial.

This treatment alone is frequently all that is required in this type of case, as the inflammation may subside; but careful watch should be placed on the temperature and a look out kept for external signs of progressive inflammation over the bone affected, that is, the classical signs of rubor, dolor, calor, and tumor.

If the symptoms and signs are found to be progressive then surgical interference of the nature of the Trephine operation of Starr is advised.
The Methods of Local Treatment are:-

(A) **Abortive Treatment**

(1) By Method of Starr which consists of opening freely into the metaphysis by multiple drill holes; (Case III.) or

(2) By the removal of a small trephine disc.

(B) **The Curative or Radical Treatment.**

(1) Diaphyseal drainage or Guttering and Carrel Dakin. (Cases I and VI.)

(2) Diaphysectomy which is indicated in two types of case. (Case II.)
   (a) In complete necrosis; or
   (b) In the neglected case.

(3) The Winnet-Orr Treatment. (Case IV.)

(4) Amputation. (Case V.)

(5) The Maggot Treatment, especially in chronic cases.

Let us now discuss these various methods in greater detail, and correlate them with the treatment used in the six cases we have described.
THE METHOD OF STARR, which consists of sub-periosteal and metaphyseal drainage.

It is out of place to set forth in detail how to prepare a patient and sterilise instruments and dressings for an operation, but brief mention of some general details is necessary.

The choice of the anaesthetic is left to the discretion of the individual surgeon, although in children, induction with Ethyl Chloride is to be preferred. In order to render the operation area bloodless, a tourniquet is employed in operations on the lower end of the femur, the tibia, the fibula, and the bones of the foot and hand. The risk of injury to the radial nerve contra-indicates employment of a tourniquet around the humerus.

During the operation a specimen of pus from the bone is collected and sent to the bacteriological laboratory for examination. If vaccine treatment is contemplated, an autogenous vaccine should be prepared.

The post-operative treatment is considered in detail in a later section.

This method is best applied in cases where the pain is still at the metaphysis, and there is no swelling of the leg, and incision down to the periosteum reveals nothing abnormal except a degree of oedema.
Fig. 25. Illustrating Incision over site of maximal tenderness.
(Note the tourniquet).

Fig. 26. Showing trephine opening.
Drills are passed into the metaphysis parallel to and close to the epiphysis. One of these drill holes may tap the inflammatory centre, and pus may exude from it. Free drainage is established by the removal of a small window from the cortex of the bone, leaving the wound well open. It seems rational to believe that the drainage of the centre of the lesion would relieve pressure and so improve the blood supply that the local infection would not spread.

Where there is much swelling of the severed tissues, it would be necessary to establish drainage from a wider area. The steps in the operation are briefly as follows.

(1) An incision is made right down to the bone over the point of greatest tenderness. Frequently pus is found beneath the periosteum. The incision is enlarged according to the amount of stripping of the periosteum. Sub-periosteal abcess is usually seen in older children and adults. (See Fig. 25.)

(2) The bone is opened with a half-inch trephine as this causes much less trauma than the chisel and mallet. A disc is removed and the interior is inspected, but the medulla is left alone and not scraped. (See Fig. 26.)

(3) If frank pus is observed within the bone a second trephine hole can be made about two inches from the
first trephine. With a chisel, the intravening bridge of bone is removed.

(4) The wound is lightly packed with gauze soaked in some such antiseptic as flavine, and a few stitches are inserted at the extremities of the wound.

(5) The leg may be placed on a back splint.

(6) The daily dressings etc. are dealt with under Post-Operative Treatment.

The Carrel-Dakin Treatment of the infected marrow.

It may be desired to supplement the treatment of free drainage with some antiseptic solution after the Carrel-Dakin method.

Through the open wound a number of perforated capillary tubes are passed into the interior of the infected medullary cavity, and through these an intermittent irrigation with Eusol or Carrel-Dakin is arranged.

After the lapse of about twenty-one days partial closure of the wound by secondary suture may be considered.
The Multiple Trephine of Starr is becoming increasingly popular. In this method the reduction of operative trauma during the acute phase of the disease - a feature which is generally accepted as most desirable and advantageous - is attained to the highest degree.

Case (III) was operated on by the Method of Starr. Adequate drainage was obtained and at first progress appeared to be taking a favourable course, when septicaemic complications ensued, followed by death.

In this case one might argue, was the drainage adequate? After exposure of the femur, a hole was drilled into the medullary cavity, and pus found to flow. Holes were then drilled at $\frac{1}{2}$" intervals right down the whole length of the shaft of the femur until at the lower end no pus flowed. A large flavine pack was inserted and the skin edges approximated over it.

It appears to me that this was adequate drainage, and the best operation for this case as trauma is minimal. I believe "guttering" the shaft of the femur would have led to infection of healthy marrow and earlier spread. Unfortunately, even by employing Starr's Method - metastic abscesses appeared, and the patient died ten days after the operation.
The result in this case is one of the factors which lead me to the conclusion that the discovery of means to combat the general bacteraemia is of more importance than the development of the technique of local interference.
CONCERNING INCISIONS for DIFFERENT SITUATIONS.

With the knowledge that the metaphysis is the original site of the disease, the incision should be planned so as to expose it.

(1) **Lower end of femur.**

Here, two facts must be remembered.
(a) do not open into suprapatellar pouch, which opens into knee joint.
(b) pus usually gravitates back to the popliteal fossa.

Therefore incise on the medial or lateral side, depending upon which side is more painful. On the medial side the adductor tubercle is the landmark. The incision is made from the adductor tubercle upwards. Access to the bone is obtained through the vastus medialis. On the lateral side the incision is made at the same level and access is obtained through the lateral inter-muscular septum. (See Case III.)

(2) **Upper end of tibia.**

The incision is made on the subcutaneous surface of the tibia, but avoid going too high because of the knee joint. (See Case II.)

(3) **Lower end of tibia.** (See Case IV.)

Incision is made on subcutaneous surface. The saphenous vein may have to be ligated.

(4) **Upper end of femur.**
Approach is made from the lateral side taking the base of trochanter as the landmark. Incision is made downwards from that point.

(5) **Upper end of humerus.**

Access to the bone is obtained from the front going in between pectoralis major and the deltoid. Care should be taken to avoid the cephalic vein.

(6) **Lower end of humerus.**

Approach can be made from either side in the region of the medial or lateral septum. On the lateral side care should be taken of the radial nerve and on the medial side the ulnar collateral artery.

(7) **Ulna.**

Approach can be made from any part of the subcutaneous surface.

(8) **Radius.**

The method of choice is to approach the bone by going between brachio-radialis and flexor carpi radialis.

(9) **Ileum or Pelvic bones.** (See Cases I and VI.)

This is a dangerous situation for osteomyelitis. There may be an abscess under the glutei and another one in the pelvis. The incision varies according to the case. If there are two abscesses, both should be opened.
THE METHOD OF WINNET-ORR.

In a paper read before the American Orthopaedic Association in 1927, Winnet-Orr advocated a special type of drainage in acute osteomyelitis and the immobilisation in plaster of Paris of all inflamed parts. He strongly advocated the discontinuance of active antiseptic methods in the after care of osteomyelitis.

The first point in this treatment is adequate drainage - larger openings are made into the affected areas than in Starr’s method - and the entire area must be left open. No attempt is made to remove all diseased bone tissue. The exposure of the infected area is partly to reduce the amount of infection present, but chiefly to give a clear field for the application of sterile dressings.

A vaseline pack is placed in and about the wound and is not disturbed for a number of weeks, or until healing is thoroughly established. No drainage tubes or sutures are employed. The wound and surrounding skin are carefully dried, painted with tincture of iodine, and the entire wound packed open and covered over with a sterile gauze vaseline mass.

The third feature in this method of treatment is the immobilisation of the affected part in a well fitting plaster of Paris cast, which includes
Fig. 27. Illustrating the condition of a wound previous to treatment by the Method of Winnet-Orr. (Ink)
the joints above and below the inflamed bone. The wound area is well covered with plaster, and is not opened except for definite and urgent signs of secondary trouble, or for change of dressings. Immobilisation should not be discontinued until healing is complete.

Winnet-Orr claims that by his method:

(1) The patient is relieved at once.
(2) Complications are effectively avoided.
(3) Convalescence is simplified.
(4) Labour and materials are saved.
(5) The patient makes an earlier recovery with a minimum of deformity and disability.

The whole object of timely treatment and early drainage is to prevent the formation of a sequestrum.

From the reports published by those who have seen the results of ORR's method of after treatment, one believes that his principles are becoming widely accepted and generally favoured.

Case IV, D.S. a little boy aged seven years, is the only Case in this series under discussion which was treated by the method of Winnet-Orr. The details of the operation are given on page 15. The patient had a slight rise of temperature three days after the operation, but this
Fig. 28. Same case as Fig. 27, showing the condition of the wound eight weeks after treatment by the Winnet-Orr method. This was the appearance on removal of the first dressing.
Fig. 29. Illustrating Diaphysectomy.
rapidly subsided, and thereafter remained below normal. Six weeks later the plaster was removed and the limb X-rayed. The wound appeared to be comparatively healthy. The pack was removed from the wound and a further vaseline pack was inserted and the limb was encased in plaster extending up to the knee. This plaster remained in position for six weeks and then only simple dressings were prescribed. The patient continued to improve and the wound healed perfectly.

Hey Groves states that the lapse of time and the satisfactory results obtained have placed the method of Winnet-Orr in the fore-front of modern methods of the treatment of Osteomyelitis.

I do not believe that the method of Winnet ORR will effectively prevent a fatal issue if toxaemia is great, but from the case in this series it appears that complications are effectively avoided, and the tendency to sequestrum formation minimised.
THE OPERATION OF DIAPHYSECTOMY.

Except in cases of acute osteomyelitis of the fibula, the operation of Diaphysectomy appears to have been abandoned.

It may be carried out when the whole shaft has undergone necrosis.

It seems to be quite certain that any attempt to cut short the disease by an extensive removal of the diaphysis in its early stages is a dangerous and useless method. It cannot be predicted in the early stages of the disease how much necrosis of bone will occur. Ideal treatment will avoid any necrosis. The removal of the diaphysis before sequestration or before the formation of an involucrum is a procedure which will almost certainly lead to a flail limb.

The method of performing diaphysectomy is briefly the division of the bone in the centre and the complete removal of the shaft in two segments. All that is left is a tunnel of periosteum. (See Fig.29)

The main disadvantages of this treatment are:-

(1) The great initial shock and loss of blood which the operation entails.
(2) The septicaemia engenders a high mortality; and

(3) The bone does not reform completely.

In the case of F.G. (Case II), a considerable portion of the shaft of the tibia was found to be necrotic. The diseased segment was resected and the cavity packed with gauze. Dressings were applied and the limb was placed in a posterior splint with the foot held in good position. This little girl now is in good health, walks well, and has regained a marvellous degree of power in the limb in which the resection was performed.

Diaphysectomy finds favour in France, but the method is abandoned in this country except in the chronic stage. Two papers, delivered to the National Society of Surgery of France, record the results of fourteen Cases. The authors of these papers did not agree on all points, and even betrayed a degree of opposition, but both appeared to be satisfied with their own results.
THE GUTTER OPERATION.

This type of operation is in common use, and is indicated when the medullary canal with its lining of cancellous bone is widely infected; for example in neglected cases of primary metaphyseal infection.

The medullary canal is exposed for a distance equivalent to the limits of the subperiosteal stripping.

There are two great disadvantages in the Gutter operation.
(1) The resultant scar is relatively avascular and adherent, especially in bones with much subcutaneous area.
(2) The amount of necrosis is increased.

Hamilton Bailey maintains that there has been improvement in results since he discarded this method of treatment.

It appears to me that extensive "guttering" of the bone, and thereby infecting healthy marrow and opening up many new vascular channels, will lead to an increase in pyogenic metastases. Case II was treated by the Gutter method on the 8th November, and the patient remained well and the wound discharged freely until the 15th November, when the temperature
suddenly rose to 104.6° and the patient became delirious, and complained of pain over the left knee joint. 25 ccs. of pus were withdrawn from the knee joint. A week later, however, the knee was incised, and the joint cavity syringed out with ether. At the same time, a considerable portion of the shaft of the tibia was found to be necrotic, and the diseased segment was resected. From this case, we might suggest that the guttering of the bone led to complications in the neighbouring joint and increased the necrosis in the shaft of the bone necessitating diaphysectomy.
While writing this paper an interesting case was admitted to Ward 7, and I took the opportunity of following the progress day by day in order to observe closely the results of a "Gutter" operation.

A young boy of 13 years was admitted to the Ward on the 11th of March complaining of pain in his left arm in the region of the elbow. He had suffered from this dull pain for about three months. Briefly the history was as follows.

About a year before admission the boy had pain in the right side of the chest which did not at that time appear to be pleurisy. This painful area was situated in the infra-clavicular region and later this became swollen, but shortly afterwards subsided. The patient remained fairly well thereafter until about Christmas 1931, when he began to complain of pain just above the elbow on the left side. The pain has continued ever since and the arm has become somewhat swollen. There is no history of septic history to the arm or any other part of the body, but the patient has been feeling rather ill and looks flushed.

**PHYSICAL EXAMINATION.**

The patient is a fairly well nourished boy, but he is slightly flushed in appearance.
Tongue: Moist and slightly furred.

Teeth: The teeth are fairly good but a few cavities are evident.

LOCAL EXAMINATION: Left arm.

There is some swelling in the region of the elbow joint at the left side, especially posteriorly.

Palpation:

The swelling is firm. It is found to contain fluid. Palpation elicits tenderness in the region of the lower end of the humerus. (See previous section on points of maximal tenderness.)

There is no tenderness in the rest of the shaft of the humerus, and there is no tenderness in the ulna or radius.

All movements of the elbow joint are free and painless.

CIRCULATORY and other SYSTEMS.

Nothing abnormal was detected in the other systems.

DIAGNOSIS.

Osteomyelitis of the lower end of the left humerus.
OPERATION.

On the 10th March under Ethyl chloride and Ether anaesthesia, an incision was made in a vertical direction along the posterior end of the humerus posteriorly, and the triceps incised in the line of the skin incision. The bone was exposed and the periosteum elevated. There was no pus either inside or outside the periosteum. Several holes were drilled into the medullary cavity and just above the olecranon some pus was found. Accordingly the bone was partially removed by means of a gouge and a cavity was found in the centre of the bone which contained pus. This was freely opened up and a rubber-dam drain inserted. The skin incision was closed with silk worm gut and clips round the drain. This was a Gutter operation.

On the 24th March, under Chloroform and Ether anaesthesia, a second incision was made over the lateral aspect of the elbow joint, and a rubber-dam drain inserted between the two incisions. This operation was merely "Incision and drainage".

PROGRESS.

After the second operation the temperature of this little patient continued to swing rather
violently, and his general condition was somewhat worse than before. Accordingly, steps were taken to give him a transfusion. However, five donors were tried and in all cases they were found to be incompatible. During the course of this investigation and while a suitable donor was being sought for, the patient's general condition demonstrated a degree of improvement and although it was found eventually that his mother was a suitable donor, it was decided that the transfusion should be withheld in the meantime.

However, on the 1st of April he developed a tender swelling over the left shoulder joint. The local temperature was raised and fluctuation was elicited in the swelling.

OPERATION.

Under Ethyl chloride and Ether anaesthesia, an incision was made over the anterior border of the deltoid. The pectoralis major was retracted downwards, and the shoulder joint opened. A large quantity of pus escaped and the upper two inches of the humerus was found to be necrosed. The cavity was emptied and the wound closed with drainage. The operation performed was "Incision and drainage of the left shoulder joint for septic arthritis".
FURTHER PROGRESS.

On the 3rd April the patient complained of pain in the right knee. On examination the knee was found to be swollen, very tender, with a local rise of temperature. The swelling was fluctuant, so the diagnosis arrived at was septic arthritis of the right knee joint.

An immuno-blood transfusion was carried out with defibrinated blood, one-half pint of blood being given from the patient's mother.

Four hours later 100,000,000 units of Anti-staphylococcal vaccine was administered to the donor. There was a temporary improvement in the patient's condition following the transfusion, but on the 5th April his condition was not so satisfactory and it was decided to drain the abscess in the right knee joint.

OPERATION.

On the 5th April under Gas and Oxygen anaesthesia, a needle was inserted into the supra-patellar pouch and some sero-purulent fluid drawn off with a syringe. An incision was then made on the medial side of the knee joint, and the capsule
of the joint opened with forceps. Some thick, fibrinous pus escaped, and the joint was thereafter cleaned out with Ether. A large, rubber-dam drain was inserted and the wound partially closed, that is, "Incision and drainage" was performed.

BACTERIOLOGICAL EXAMINATION:

All specimens of pus obtained from these lesions showed very degenerate polymorphonucleur leucocytes, and large numbers of staphylococci.

FURTHER PROGRESS.

Following the evacuation of the knee joint the patient was given 10ccs. of a one per cent. solution of Mercurochrome intravenously. The effect of this injection was only temporarily beneficial, and the patient soon reverted to a markedly toxaemic state. His condition became gradually worse, the pulse and respiration rate continued to rise, and in spite of a brave struggle on the part of the little patient, he succumbed on the 12th April.
This case illustrates very clearly what appears to me to be one of the peculiarities of osteomyelitis, that is, the fact that in spite of skilled surgical intervention, the performance of the operation indicated by the symptoms and signs, by removal of the focus of infection and by the administration of all the general means available to modern medical science for counteracting infection .... the patient was taken away by the effects of profound toxaemia.

PERSONAL COMMUNICATION.

W.G. Eastwood, of Liverpool, has been working on the treatment of osteomyelitis, and is about to publish a paper communicating his results. He maintains that the results abundantly indicate that the best method is early and effective drainage by a special type of Gutter operation, the main characteristic of which is the avoidance of trephining healthy tissue. A narrow gouge is used to remove one half of the circumference of the bone - the other half being left open, and a rubber-dam drain inserted. He states that the percentage recurrence is diminished, and this is borne out by his series of cases.
AMPUTATION.

Indications for amputation. These are:-

(1) **Acute General Infection.**

Amputation is occasionally performed in the endeavour to avert death from acute toxaemia, septic-aemia, or pyaemia. (See Case V.)

(2) **Acute Infective ARTHRITIS.**

In this case two severe foci of infection are present, either of which may be fatal. Even if the patient's life is jeopardised and the limb eventually safed, stiffness of the joint and surrounding structures severely impairs the function of the limb.

(3) **Spontaneous FRACTURE.** (See Fig. 17.)

This may occur in cases of virulent infection, and the resultant limb, if saved, will be markedly impaired in function.

(4) **Secondary Haemorrhage.**

Where attempts to ligature the bleeding vessel or ligature in continuity have failed.

(5) **Chronic Infection.**

Where, as a result of chronic toxaemia, septicaemia or pyaemia, the general health of the patient fails, secondary abscesses develop or amyloid disease supervenes.
Those who have had experience with cases necessitating amputation have found the results most gratifying. They report rapid improvement and disappearance of toxaemia and febrile symptoms shortly after the removal of the limb.

To my mind, amputation would be without avail if time is allowed for secondary pyaemic manifestations to take place.

Case V, (Mrs. G.E.) illustrates the occurrence of osteomyelitis in a woman aged 30 years as the result of an accident in which she received a supracondylar fracture of the left femur. This was treated by insertion of Kirschner's wire and extension applied, the limb being put up in a Thomas splint with knee-piece and suspended in a Balkan frame. A fortnight later the Thomas splint and extension were removed and the limb put in plaster. A week later she was discharged from Hospital with the Kirschner's wire still in. Six weeks later the patient was readmitted to Hospital suffering from severe pain in the left knee and it was decided to remove the plaster. It was found that the patient was suffering from osteomyelitis of the femur. Another plaster was applied and a large window cut on each side. The patient complained of considerable pain in the lower end
of the femur and considerable discharge commenced to escape through the tissues on both sides of the lower end of the femur about ten days later. The section of plaster between the windows over the front of the thigh was removed and hot fomentations applied and then the complete plaster was removed. The patient’s temperature was swinging from 99 to 103. She complained of very little discomfort in the leg, but the limb around the knee was extremely hot and inflamed looking. The knee joint was aspirated, but no fluid was obtained, so the joint was incised and the incision was partially closed over a rubber-dam drain. Two days later (as described on page 23) a sequestrum was excised from the lower end of the femur. The patient continued to go down hill, the temperature was swinging violently, and she showed all the signs of a grave toxaemia, so an amputation was performed, but, as is stated on page 24, the patient never rallied after the operation, and she died about five hours after returning to the Ward.

(In this case there is always the possibility that a degree of infection was introduced into the bone on insertion of the Kirschner’s wire.)
ACUTE OSTEOMYELITIS in ADULTS.

Although osteomyelitis is essentially a disease of the age of growing bones, the condition is also found in adults. However, when an adult is afflicted with acute osteomyelitis, the picture is neither so definite nor so clear as in the juvenile disease. The main cause of this is the fact that the transition of bone from cartilage has come to an end. The initial lesion does not appear in such well defined situations as in the young child, and anatomical conditions are somewhat different. Staphylococcal infection finds a suitable soil in the medullary as well as in the juxta-epiphysial tissue (Tubby). Knaggs states that from his examination of numerous specimens, he has come to the conclusion that infection excites trouble more readily at those parts where the bone is growing from cartilage, and the medullary invasion is also composed of newly formed tissues. With the completion of growth and the disappearance of the juxta-epiphysial regions there naturally follows a want of uniformity in, as well as a diminished frequency of, its manifestations.

The specimens of the adult variety of osteomyelitis which one finds in museums, fall into three types -
(1) There is a necrosis of a portion of compact tissue, and this becomes walled up in a cavity by new periosteal bone. Pus finds a way through this covering and even without an X-ray examination, the nature of the case can be recognised. However, when the infection is of an attenuated virulence, it may be months before an obvious abscess forms, though the continued irritation may lead to much boney deposit, and thickening of the adjacent soft parts.

(2) Here there is involvement of the cancellous tissue, often to a considerable degree. As there are no epiphysial discs to check its progress, the suppuration in the bone may reach the articular surface and implicate the joint. It may also perforate the compact layer of the shaft.

(3) The third type of case is the Brodie's abscess. (See Fig. 20.) In many cases of adult osteomyelitis, no source from which the trouble may have originated can be found, although in others, a suppurating focus, such as pyorrhea alveolaris, abscesses in various parts of the body or febrile infective disorders, are associated with the onset of the bone condition.
ACUTE TRAUMATIC OSTEOMYELITIS.

(Illustrated by a Case).
Case V.

Acute Traumatic Osteomyelitis arises in cases of compound fracture or of septic amputation when drainage has been inadequate.

The limb is swollen and painful, the wound is unhealthy and septic, and in its depth dead bone may be felt or seen. The patient shows signs of septic absorption, with a high temperature and a furred tongue, and he may have repeated rigors suggesting pyaemia. On an amputation stump a conical sequestrum will form and will separate very slowly.

This condition should be prevented by adequate treatment of an infected wound often by primary excision, and by the establishment of adequate drainage. Once it has occurred the wound must be widely opened, the infected bone exposed, and the bone itself so far opened up that pus cannot collect in the medulla under pressure. In severe cases, amputation or re-amputation may be the only resource, and it will probably be better to carry them out at such a level as may ensure asepsis.
POST OPERATIVE TREATMENT.

LOCAL TREATMENT.

This entails much care and patience in order to reduce disturbance of the patient to a minimum. Fresh dressings should be applied to the wound twice daily (unless the post-operative treatment involves the technique already described, such as the Carrel-Dakin). In some cases with profuse suppuration - more frequent changing of dressings may be indicated. The wound should be well washed out with saline, syringed with hydrogen peroxide, or irrigated with flavine.

REGARDING X-RAYS.

Continue the taking of X-ray photographs during after treatment so as to be sure that no dead bone has been left behind. It is impossible to select particles of necrotic bone inclosed in small cavities except by repeated X-ray photography. It is suggested by some, that stereoscopic views are of much value in this direction.
The POST-OPERATIVE COMPLICATIONS.

The pathological complications of osteomyelitis have already been discussed and some mention must be made of the post-operative complications. These are three in number, namely:

(1) Haemorrhage;
(2) Cellulitis and
(3) Arthritis. (See p. 8.)

The haemorrhage, if slight, can be treated as in any other operation by the administration of haemostatics such as adrenalin or haemoplastin. If the haemorrhage is of a severe nature the wound should be opened, the bleeding vessel secured and ligated.

The cellulitis, which is a relatively common feature to a greater or less degree in all these operations, usually responds to local measures.

If an arthritis supervenes, rapid local treatment in the form of counter-irritation and soothing applications should be commenced at once in order to save the joint from the possible after effects of incision and drainage.
THE DEFORMITIES of OSTEOMYELITIS.

We may postulate that the younger the patient in whom osteomyelitis occurs, the greater is the possibility of the occurrence of deformity.

If the return to normal after operative procedure is not perfect, then various degrees of deformity may follow. There may be -

(1) Hyperostosis.
(2) Sclerosis.
(3) Curving of the bone.
(4) Shortening, due to interference with growth at the ossifying junction.
(5) Exaggerated growth may occur, but is rare.
(6) Obliquity of the bone may ensue, when one half of the epiphysial cartilage is destroyed and the other half continues to form bone.
GENERAL TREATMENT.

The first principle in the general treatment is the liberal administration of fluids by mouth, rectum or intra-venously. The rectum can absorb large quantities of fluid; a litre can be absorbed in about two hours and in the course of a day, several litres can be administered in this way. The best method is to run warm 0.9 per cent. saline slowly into the rectum.

In most cases a certain amount of general medicinal treatment is required in reference to:-

(1) aids to elimination.
(2) prevention of heart failure, and
(3) to prevent abdominal distension and diarrhea.

The diet should be simple but sustaining.

The Toxaemic Symptom shown in unfavourable cases.

The Cardio-vascular system is generally affected and the toxaemia exerts an influence on the vaso-motor system in particular and vaso-dilatation occurs. Dilatation of the peripheral blood vessels causes a marked fall in the blood pressure, both systolic and diastolic. The heart itself is also affected, and this adds to the fall in blood pressure. The pulse rate increases (see Case I and
Case III) and dilatation frequently occurs, irregularities appear, and all the signs of Toxic Myocarditis.

Rather than give Digitalis it is best to wait for cardiac distress and then give Strophanthin gr. $\frac{1}{400}$ or Camphor in Oil.

Nervous Symptoms.

Pain, Restlessness, Sleeplessness and other nervous manifestations can be dealt with according to the individual case by the administration of Morphine, Nepenthe or Heroin. Opiates are not justifiable in the presence of bronchitis, when Atropine gr. $\frac{1}{400}$ is advisable.

Alimentary System.

The toxaemia causes gastro-intestinal upset - a disinclination for food, constipation or diarrhoea. Paresis of intestine may occur, resulting in abdominal distension. This distension further impairs the action of the heart, and can be counteracted by the use of Pituitary $\frac{1}{2}$ - 1 cc. and Eserine gr. $\frac{1}{40}$. 
CERTAIN SPECIFIC DRUGS USED.

Mercurochrome - 220.

This is a compound of mercury and fluorescin and contains 23 per cent. of mercury. It has been used extensively in infective conditions, but more particularly as a urinary antiseptic.

In cases of osteomyelitis it can be applied locally as a one per cent. solution. It is best injected intravenously in a dose of 5 Mgm. per kilo. of body weight. The evidence concerning the value of intravenous injections of mercurochrome as a method of treatment of septicaemia is remarkably conflicting, and does not permit of any definite conclusion. The results of its use in Wards 7 and 8 indicate that it is of no outstanding merit.

Colloidal Manganese.

This substance can be given intramuscularly in a dose of from 0.5 to 1cc. Apart from a little soreness in the muscles, it causes no reaction.

Colloidal tin and Stannous compounds (which can be administrated orally) have also been used.
The rationale of the use of the above drugs is based on experimental evidence indicating a degree of anti-microbial effect on the staphylococcus. Reports from many quarters suggest beneficial results and justify their administration.

**Nucleic Acid** is given with a view to increasing leucocytic response. It may be used as Sodium Nucleate or as Anti-Microbium - in lcc. capsules, taken orally every 3 - 4 hours. Yeast serves a similar purpose.

**Colloidal Iodine** has been used, by mouth and intravenously with no evident discomfort. Intravenously as much as 500ccs. may be given. Perchloride of Mercury has been given intravenously in a dose of \(\frac{1}{32}\) gr. in a 5cc solution. There is little evidence of their therapeutic value.
R. STETSON refers to the excellent results of blood transfusion in children suffering from osteomyelitis. Convalescence is greatly shortened and the dangers of intercurrent infections much lessened. He concludes that a great many cases could be saved if transfusion were started early and given every forty-eight hours until the blood cultures became sterile and the clinical improvement sufficiently marked to make it safe to stop; in most instances it is best to give only 500 - 600cc. of blood - less in young children. He withdraws from the patient one-half to two-thirds of the amount to be given, just before starting the transfusion. It is evident that the most dreaded complications are pneumonia and meningitis. Escaping these, and given a fighting chance, blood transfusion offers any patient with septicaemia at least a fifty per cent. chance for recovery.

In this country, however, the experience of many surgeons seems to indicate the blood transfusion is of little value in cases of infection.
Blood transfusion can be given for a variety of conditions.

(1) because the patient has had a haemorrhage.

(2) as a result of prolonged toxaemia patient has developed an anaemia.

(3) because the patient has lost the power of agglutination.

(4) in order to give the patient either polymorphs or serum containing antibodies.

In (1) and (2) we wish to give red blood cells.

In (3) an enzyme and platelets should be administered.

In (4) polymorphs and serum should be given.

Red cells are transferred by means of a citrate transfusion. Enzymes are given by intramuscular injection of 20 cc. of patient's own blood. Platelets are transferred by direct transfusion and polymorphs and serum by defibrinated transfusion.

There are two other types of transfusion which may be employed in osteomyelitis, namely, Specific and Non-specific immuno-transfusion. By these means we raise the resistance of the patient.
The immune bodies and polymorphonuclear leucocyte content of the blood of the donor is raised.

In Non-specific immuno transfusion 100 million units of staphylococcal vaccine are administered to the donor four hours before transfusion to the patient takes place.

The vaccine given to the donor is the poly-valent staphylococcal vaccine.

In order to administer a Specific immuno-transfusion, we must prepare a vaccine from the patient. The donor receives two doses at intervals of a week and three days after the second dose has been given, the transfusion is carried out by the defibrinated method.
The results of blood transfusion in the cases to which one has had the privilege of access in Wards 7 and 8, (especially Case I and page 116) show that no lasting benefit has been produced, and can only be described as disappointing: - this may be purely an unfortunate coincidence.

Immuno-transfusion (stock-vaccine method) or the transfusion of blood from a donor previously injected with a blood culture from the patient, have given results of little more value than the use of whole blood. (See page 13.)

RADIOTHERAPY.

The use of X-rays in the treatment of chronic septic wounds, arthritis, teno-synovitis and osteomyelitis, has been advocated and emphasised by orthopaedic surgeons from time to time. Some authors believe that the X-ray is probably the greatest but least used therapeutic agent in the orthopaedists' armamentarium. A few years ago there was much anticipation regarding the future establishment of X-ray therapy departments in all large orthopaedic clinics; and the passage of time
has shown adequate justification for, and to a great extent the realisation of, this hope and prophecy. By the use of a proper technique many excellent results can be safely brought about; but radiotherapy is of no avail in acute osteomyelitis.

**VACCINE TREATMENT.**

Vaccines of either the Stock or Autogenous variety can be administered sub-cutaneously or intravenously. These should be given when the temperature is low and when toxaemia and fever are not too pronounced, as there may be a fairly-marked general disturbance, headache, languor and rise in temperature. Vaccines are of most use when dealing with Staphylococcal infections or B.Coli, but prove of little avail in Streptococcal cases.

**SERUM TREATMENT.**

Anti-staphylococcal serum is used, but does not appear to have any great therapeutic value or to possess potency as a combating agent in this condition. Serum treatment is of most value in Streptococcal or Pneumococcal cases. In the early days when first introduced, only 5 cc. were given sub-cutaneously, but at the present time up to 100cc. are given intravenously. (See pages 3 and 13.)
STAPHYLOCOCCAL ANTI - TOXIN.

Recently, the study of Staphylococcal anti-toxin has been taken up by Burnet in America. He has prepared a filterable exo-toxin from staphylococci and an anti-toxin which is found experimentally to be very good in protecting animals from infection.

The Wellcome Research Staff have concentrated this anti-toxin, and it is now at the disposal of the Wards of Edinburgh Royal Infirmary and has been used in a number of recent cases in Wards 7 and 8; but the results do not appear to be as satisfactory as was the hope engendered by the experimental successes with animals.

TREATMENT of ANAEMIA.

In anaemic states - during the period of convalescence, Ferri. Sacc. Carh. is considered to be of value. In the general treatment iron, phosphorous and calcium can be exhibited. Parathyroid extract in 1/10th grain doses, and 2 minums of tincture of iodine are administered. Ostelin in doses of 1 to 2 minums or Radiostoleum capsules are also recommended.
It is not the object of this paper to treat of the chronic inflammations of bone, but, as chronicity is so frequently the sequel of acute conditions, brief mention of the surgical treatment of chronic manifestations is necessary to complete a review of the subject.

Removal of sequestra and reparative treatment still dominate the surgical field in this country.

In chronic osteomyelitis the lesion heals superficially, breaks down, reheals, only again to break down over a period of years, with a chronic discharging sinus or sinuses and gradual depletion of body resistance. Extension to other bones of the body, not infrequently occurs. These patients become chronic invalids. There is usually a history of repeated operations and accompanying neuroses.

Many varied methods of treatment have been stimulated by the recurrence or continuance of the infection in these cases.

When osteomyelitis occurs in adults, swelling and tenderness do not manifest themselves to the same extent as in children - but the pain may be excruciating, and there is frequently increase in local heat. (See Fig. 21.). If drained early, the course of the disease is not unfavourable.
Case Illustrating Preservation of the Limb and Chronicity.

P.E.  
Age 7 years  
Admitted 1/1/32.

COMPLAINT:  Pain in left wrist.

DURATION:  Three days.

HISTORY:  Three days before admission patient fell from a wall with her left forearm under her. The wrist was twisted. The wrist-joint became swollen and very painful, and as this did not in any way subside or improve she was brought to the Edinburgh Royal Infirmary. There is no history of previous injury to the arm. The patient, however, spent eight months in a Sanatorium when she was a baby.

PHYSICAL EXAMINATION:  The patient is a healthy-looking little girl. The face is rather flushed and she is a trifle apprehensive.

The Tongue  -  Slightly furred.
Teeth  -  Fairly good.

Local Examination:

Left Wrist.  Inspection:  The wrist is held in a semi-flexed position. There is considerable swelling over the lower end of the radius and the wrist-joint. There is no redness over the area involved.
**Palpation:** There is a definite increase in local temperature, over the wrist. Tenderness is complained of over the lower end of the radius and for a matter of 2" above it. Tenderness is also elicited on pressure over the distal end of the ulna.

**Movement:** There is no limitation of movement.

**X-Ray Examination:** Reveals no abnormality.

**General Examination:** No abnormality detected in the other systems.

**Diagnosis:** Osteomyelitis of lower end of radius, left.

**Operation:** Performed on 1st January, 1932. Anaesthetic used was Ethyl Chloride and Ether.

An incision was made on the posterior aspect of the base of the radius and the subcutaneous and deep fascia incised. About a teaspoonful of pus was found lying just superficial to the periosteum and the lower end of the radius. The pus was evacuated and the periosteum incised. One or two holes were drilled into the medullary cavity of the bone but pus was only found at the distal end. Accordingly a small drain was inserted and the skin incision closed with interrupted silk worm gut. The limb was then
bandaged to an anterior splint.

"Incision and drainage" operation was performed. Examination of the pus revealed staphylococci.

**PROGRESS:** On 12th January 1932 the limb was put up in plaster of Paris incorporated in which was an aluminium strip so curved as to keep the wrist in the cock-up position.

Anaesthetic used was Ethyl Chloride and Ether.

**DISCHARGED** on 15th January 1932 wearing the plaster, with instructions.

**PROGRESS:** This little girl reported at Ward 7 on March 11th, 1932, and her general condition was found to be very satisfactory. Locally, however, an X-Ray reveals that there is a good deal of disease at the lower end of the radius. There is now evidence of the formation of a considerable amount of involuerum.

Advice was given to her parents regarding the application of simple local dressings to the sinus in the hope that it may close up; but, meantime the little patient will be kept under observation by reporting for further examinations at monthly intervals.
Fig. 30. Chronic Osteomyelitis of lower end of femur showing irregular bone architecture with thickening of shaft.
Certain factors which contribute towards Chronicity in Osteomyelitis.

(1) The wound does not heal completely because there is a rigid cavity, the walls of which cannot collapse or fall together.

(2) The drainage opening may be too small to permit of adequate removal of the inflammatory products from the interior of the bone.

(3) Sequestra maintains infection.

(4) Chronic osteomyelitis may be due to some local source of infection. This was a prominent feature in the past, especially in reference to amputation stumps; and, at the present time, the constant ulceration and repair of an adherent scar may cause persistence of symptoms.
Fig. 31. Diffuse pyogenic osteomyelitis of shaft of femur, demonstrating formation of involucrum, and showing cloaca formation.
In cases where the surgical treatment has been entirely inadequate the sequestrum may include the whole diaphysis, and this may be surrounded by a thick involucrum, pierced by cloacae, through which pus finds its way to the surface. In such a case the sequestrum may take months to separate, and serious constitutional results are bound to occur from the continuous absorption of toxins.

It is better to cut the process short by opening up the involucrum and detaching and removing the sequestrum. Such a sequestrum may be clearly seen in an X-ray film surrounded by a clear zone which separates it from the living bone of the involucrum, whilst it is readily felt by a probe passed down through a sinus.

With early and adequate treatment complete closure and satisfactory reconstitution of the bone can be obtained. Where, however, a dense involucrum has formed, a cavity may be left in the bone so densely sclerosed that there is no tendency to closure. In these cases an attempt may be made to sterilise the cavity with alchobol and hot air, and to fill it with some such material as mutton fat and iodoform. A more effective plan is to obliterate the cavity by the removal of the whole boney wall on one side, turning over skin flaps to cover the remaining surface.
TREATMENT OF CHRONIC OSTEOMYELITIS

When we ask ourselves what is the best mode of treatment of chronic osteomyelitis, we must remember to take into consideration two main points: first, the existence of sequestra which require removal, and second, the possible occurrence of a cavity which fails to close even after the sequestra which lie in it have been removed.

We may postulate that the treatment of chronic osteomyelitis depends upon the stage to which the disease has progressed. Before the sequestra have had time to separate, treatment should be confined to rest of the limb upon a splint, incision down to the bone whenever pus requires evacuation, and daily dressings which may be carried out either with a septic gauze or with an antiseptic.

During this stage we must take measures to diminish the virulence of the sepsis. Thus, in large abscesses and tracks irrigation through Carrel's tubes or daily irrigation of the wound with such an antiseptic as Eusol may assist (see page 102). The patient must be watched all the time for evidence of fresh infection, which is manifested by the appearance of general symptoms, such as a rise of temperature, or of local symptoms such as swelling and other inflammatory signs in some new situation.
When we come to the conclusion that the time is now ripe for the removal of sequestra after such procedures as examination with probes inserted into any sinuses which may be present or by X-ray examination taken in two planes at right angles to each other, or by stereoscopic X-ray plates - a thorough operation should be performed. In certain cases, more particularly in the smaller bones, it may appear that only one or two sequestra are present, and that these can be easily reached. If we believe this to be the case, it may be sufficient to perform a simple opening up of the sinuses and freeing and removing the sequestra.

In the larger bones, however, we must explore by means of a free incision by whatever route will expose the bone best (see page 104). The whole of the infected area of bone should be examined, cavities and tracks opened up by chiselling away over-lying bone, and every effort made to remove all the sequestra that are present.

If it then appears that a cavity is left which may not fill because there is no soft tissue which can fall into it, the walls of this cavity should be chiselled away and bevelled down as much as possible without unduly weakening the shaft of the bone (Saucerisation). Free removal of scar tissue
should be performed, and, if thought necessary, a flap cut from some neighbouring muscle must be freed so that it can fall into and fill the cavity. If all sequestra, scar tissue and granulation tissue have been thoroughly removed, it may be possible after treating the wound with (Bipp) paste to suture it. A small drainage tube should be left in the wound.

If, however, we are in any doubt as to the removal of the whole of the septic tissue, it has been found that it is better to leave the wound open, inserting some form of antiseptic pack and allowing it to granulate until it is seen that the bone has completely granulated over, and that no further dead tissue remains. When granulations cover the whole of the surface of the bone, the wound may be closed by secondary suture.

There are two main dangers in relation to excision of sequestra:—
(a) The epiphyseal growing cartilage may be damaged; and
(b) The involucrum may not form a complete new bone.

If, after operation, in cases of chronic osteomyelitis, the tonsils are observed to be infected, then Tonsilectomy should be performed.

I venture to suggest that, apart from the
removal of the factor (e.g. - sequestra), which by continual irritation maintains the infection, there are certain principles of general treatment which would minimise to a great extent the chronicity of osteomyelitis. In brief, these principles are -

(1) The securing of increased elimination of waste products through the bowel by mild aperients, and through the kidneys by waters having a proved diuretic effects.

(2) Improvement in the circulation and acceleration of the flow of tissue lymph, thereby enhancing the rate of dislodgment of waste products from the tissues and the supply of fresh nutriment from the blood.

(3) Through the resulting changes in general metabolism, securing increased resistance to disease, and increased power of recovery. Recent research tends to show that the bactericidal power of the blood may be raised by radiant light and heat baths, by ultra-violet rays, and by procedures, such as the liver pack, that cause a powerful stimulation and reddening of the skin.

(4) The regulation of the intake of food according to the needs of the particular case.

(5) The regulation of the amount of exercise or rest.

(6) The securing of conditions having a psychological
effect, such as change of scene and surroundings, absence from excessive work and worry, suitable congenial occupation and recreation.

Of the Cases under discussion, Cases II, IV and VI should regulate their lives as far as possible in accordance with these principles.
RECURRENCE may be said to result from the following factors:-

(1) incomplete removal of infection at time of operation.
(2) inadequate post-operative care.
(3) depletion of body resistance.
(4) the offending organism being of a rather virulent nature.

CONCERNING THE MAGGOT TREATMENT.

Osteomyelitis is doubtless more common in the United States than in this country, and the attempt to find new, safer, and shorter methods of treatment indicate that surgeons are not satisfied with routine methods. The new Maggot treatment will not be readily welcomed by surgeons brought up to abhor fetid discharges, and larvae of all kinds; but if further experience reveals that they offer real advantages to the patient they are bound to be adopted at all aesthetic costs.

The late Dr. William S. Baer of the Johns Hopkins University, Baltimore, Maryland, was the first to use maggots as a living antiseptic in 1928. However, reference to the use of this form of treatment is to be found in an article by
D.J. Larrey, "Des Vers ou larves de la mouche bleue" (Clin. Chir. 1829, 1, 51).

Shortly after his death there appeared in the Journal of Bone and Joint Surgery an article by Dr. Baer, bearing the rather interesting title of "The Treatment of Chronic Osteomyelitis with the Maggot (larvae) of the Blowfly".

Dr. Baer's original paper was read before the annual meeting of the American Orthopaedic Association in June 1930. Since the days of Ambroise Pare, and very likely before then, observations have been recorded of the healthiness of wounds infested with maggots, and in the American War of Northern versus Southern States, one Southern surgeon seems - according to Dr. Baer - to have used larvae therapeutically. Dr. Baer's attention was drawn to the subject by the discovery in France during the late war of two soldiers who had been missing for days, whose wounds were crawling with maggots. Although these two men had compound fractures of the femur and large wounds of the scrotum and abdomen, and although they had lain on the ground with their wounds undressed for seven days, their condition, so far as infection was concerned, was excellent. This experience set Dr. Baer thinking, and when he was once more able to carry on investigations at
Baltimore, he set to work to study the question, and, as far as possible, to reproduce the conditions experimentally. It was found that the naturally grown larvae of the blue- and green-bottle flies could not safely be employed as they might have contained pathogenic micro-organisms or spores. Careful and repeated experiments showed that their eggs could be cultured and obtained free from all infection, and that such larvae could be kept alive and active in wounds for at least five days before they pupated. The paper contains reports of eighty-nine cases thus treated, and Dr. Baer's conclusions were as follows:

(1) Maggots have been found to be a tremendously useful adjunct to thorough surgical treatment of chronic osteomyelitis, and, in our opinion, are far more successful in securing permanent healing of these extensive wounds than any other method tried by us.

(2) Maggots, by their digestive action, clear away the minute fragments of bone and tissue sloughs caused by operative trauma in a way not accomplished by any other means. This is a tremendously valuable asset in the healing of a wound.

(3) Maggots cause wounds to become alkaline, and in this way diminish growth of pathogenic bacteria.
(4) Maggots seem to have other more subtle biochemical effects within the wound itself, and perhaps cause also a constitutional reaction inimical to bacterial growth. This is under investigation.

(5) Maggots as raised and sterilised in the manner described may be used in any wound without risk to the patient.

(6) The post-traumatic or post-operative general condition of the patient is better in maggot treatment than in the older forms of treatment where infection was combated by chemicals or other types of dressing. There is less absorption and less toxic reaction.

(7) In open tubercular abscesses, with or without secondary infection, wide exposure followed by maggot treatment has proved surprisingly effective in a number of cases, and will be given further trial.

This paper, coming from such an authority, and supported by such an amount of carefully stated evidence, must attract attention, and further reports will be awaited with interest.
A FEW DETAILS OF THE MAGGOT TREATMENT.

The post-operative use of maggots is said to supplement the operation and complete the work of the surgeon. The mode of action of these scavengers is two-fold in nature:-

(1) they seek out the small undiscovered pockets of infection not removed at the operation.

(2) they feed upon and digest any bacteria and detritus present.

THE TYPE OF MAGGOT.

The maggot employed is of the green-bottle fly (calliphora erythrocephala) family muscidae.

They can be bred in specially constructed incubators furnishing an atmosphere with constant temperature and humidity.

The flies are fed and the eggs collected. The eggs hatch into maggots within twenty-four hours. The maggots remain as such for seven days and grow rapidly during this period. They then undergo a second change forming pupas. In this form they are dormant and require no food. The eggs are sterilised for one hour in 1:1000 bichloride of mercury containing 25 per cent. of 95 per cent. alcohol.
S.K. Livingston of Illinois, describes the technique of applying maggots to the post-operative treatment of osteomyelitis. In tuberculous and chronic pyogenic osteomyelitis, a radical sequestrectomy is performed. The wounds are not sutured but are packed with plain sterile gauze for forty-eight hours to control haemorrhage. The gauze is removed at the first dressing, the wound is thoroughly irrigated with normal saline and maggots 48 hours old are introduced. The number of maggots introduced depends upon the size of the wound. This treatment is repeated every three to five days depending upon the severity of the infection. At each dressing the wound is washed thoroughly with normal saline and new maggots are introduced. This procedure is followed until the wound is completely filled with granulation tissues.

The dressing consists of four layers of non-sterile crinoline (fine mesh) alternated with four layers of finely woven gauze cut to the desired size. The dressing is held to the skin by three inch adhesive strips of the proper length placed in a rectangular manner over the borders. The dressed wound is exposed to natural or artificial light for two or three hours. This causes the maggots to bury themselves into the recesses of the wound.
In about twenty-four hours after each dressing the wound generates a brownish red offensive foam which wells through the dressing. This discharge consists of serum, bacteria, pus, and a healing secretion (active principle), the origin of which has not as yet been determined.

**HOW DO THE MAGGOTS ACT?**

Maggot action is said to be divided into three elements, namely:--

(1) mechanical action,
(2) serum production; and
(3) active principle production.

In a series of one hundred cases reported by Livingston of Illinois, he claims to have had 95 per cent. cures, and he states that the success of this treatment does not alone depend upon the scavenger activities of maggots, as there appears to be some additional agent developed within the wound which is sufficiently powerful to overcome infection and permit the normal hydrogen-ion concentration balance to be established. This agent is believed to be a bacteriophage.
It is extremely difficult to assess the value of the respective operative procedures for this condition, due to the fact that the death of the patient is determined frequently by the generalised septicaemia and not by the operative interference.

At this juncture it is fitting to make brief reference to a Meeting of the Section of Surgery of the Royal Society of Medicine, which took place on the fourth of November, 1931.

At this Meeting, a discussion on the treatment of Acute Osteomyelitis took place. The great variety of opinions expressed indicate the different trends of thought and attitudes adopted by the surgeon of the present day in relation to the operative treatment of this condition.

Let us illustrate this difference of opinion by referring to a few examples of the beliefs stated at that Meeting.

MR. GWYNNE WILLIAMS:— "I belive in ORR'S Method of plugging with a vaseline dressing and enclosing the limb in a plaster splint. The smell is foul
MR. C.P. HOLMAN:— "I think it might be advisable to defer operation until the acute stage has passed — and I believe that interference with the bone should be reduced to a minimum."

MR. O.L. ADDISON:— "I regret an apparent return to the surgery of seventy years ago, which was responsible for filling pathological museums with specimens. Trephining cannot provide adequate drainage. Those who find sequestra following their operations have failed to secure efficient drainage. I am of the opinion that where there is severe involvement of the femoral shaft AMPUTATION is the best treatment. Treatment by trephining can never be successful except in the earliest and mildest cases."

MR. KENNETH HERITAGE:— "I find the results of Starr's Method of treatment satisfactory where the diagnosis is made easily."

MR. GWYNN WILLIAMS:— "I reply that I do not claim that adequate drainage is provided by the trephining operation — but I do not believe that this is secured by the Gutter operation either. The mortality rate has not been reduced by guttering the bone."
The great variety of opinions expressed and the evident lack of unanimity betrayed by this meeting of the Royal Society of Medicine, suggests to me that on the whole, it must still be admitted that the famous quatrain of Edward Fitzgerald serves as a useful warning:

"Myself when young did eagerly frequent Doctor and Saint and heard great Argument About it and about: but evermore Came out by the same door as in I went."

Attention must be drawn to the persistence of infection and its recrudescence, often after many years, in cases of bone disease which are reported in present day literature. It would appear that a very important problem in the subject under discussion is the possible effect of the primary method of treatment on the ultimate after history.
It appears to me (in spite of my inexperience and slight personal acquaintance with cases of osteomyelitis) that a useful purpose would be served by insisting that there are two broad types of osteomyelitis. I have seen but few cases of osteomyelitis from the date of admission to the date of discharge or death, but I have been privileged in having access to the more general statistical Reports of Wards 7 and 8. The difference between these two types of osteomyelitis is accentuated by the mode of termination of the condition.

One may say that there is:

(1) A condition in which Septicaemia or Bacteraemia is complicated by Osteomyelitis but the toxic manifestations predominate.

(2) A condition in which Osteomyelitis is complicated with Septicaemia.

The prognosis in condition (1) is very different from that in condition (2), because in the former the mortality ranges from 60% to 80%, no matter what type of surgical intervention is employed, whereas, in the latter a fatal issue is a comparatively rare occurrence.
Why do acute infections become chronic?

On thinking over this problem for the first time, one is apt to lay too much blame on the surgical technique employed in an attempt to eradicate the condition. There are other factors to be considered in the elucidation of the problem, such as, tardiness in sending the case into hospital. The responsibility for this can fall on the shoulders of:

(a) the family doctor, and
(b) the parents of the child.

The onus is allotted to the physician when only a brief and cursory examination leads to an erroneous diagnosis.

The parent is not really at fault - it is public opinion which has engendered the belief that pains in the extremities are "growing pains" - and by the time medical aid is called, the damage is done.

Therefore, I believe that education of the public and the development of increased diagnostic exactitude on the part of our general practitioners - (apart altogether from treatment) - are factors of prime importance if we are to hope for a future without the ravages of the complications of osteomyelitis, and the chronic invalidism attendant upon them.
In discussing the merits of this new, dramatic and unorthodox method of treatment, we must not be too hastily critical, and we must recall to our mind the fact that the basis for this Maggot Treatment is sound and dates back to the sixteenth century.

Goldstein points out that Ambroise Pare in 1557 and Lairey (1766 - 1842) and many other writers observed that maggot infested wounds healed well. Lairey claimed that this infection promoted the cicatrization of wounds by cutting short the process of nature. He drew attention to the phenomenon that larvae "were greedy only after putrefying substances, and never touch the parts which are endowed with life".

The adoption of the maggot treatment as a rational mode of treating osteomyelitis will depend upon many factors.

In the first instance, there is a strong natural prejudice against vermin, and also medical education teaches the avoidance of foetid discharges. Again, there is the psychological factor which has to be considered - the fear or apprehension of the individual knowing that there is something alive - a crawling animal - in his wound!
Other factors which have an important bearing are:

(1) the expense of maggot production and sterilisation.

(2) the expense of a highly trained nursing staff, and a special Hospital in which to treat the cases.

It seems to me that the main question is: Are the results justified by the technique? - that is, is there any other method which is of shorter duration, of a more simple nature, more pleasant and with equally satisfactory results.

In acute cases the answer is in the affirmative - for example, the Method of Winnet-Orr, or Starr have results easily out-distancing the results of maggot therapy.

In reference to chronic osteomyelitis, I feel we have no really satisfactory method of treatment; and are we not just a little tardy in accepting the doctrine of Dr. Baer because we have a distinct tendency to be loathe to depart from immemorial precedent?
Reviewing shortly the treatment of osteomyelitis, it is remarkable how often the suggestion is made that this disease is incurable. Whether the basis of treatment is founded upon one or more theories as to causation and pathology, it is impossible to believe that in cases of such varying severity some do not recover. The literature supports this view, though it naturally dwells upon the obstinacy and somewhat progressive nature of a great number of cases.

It is also interesting to note that all kinds of treatment have been credited with good results, but we must remember that in all these the general care and attention directed to the patient must play a part. Both general and special methods have met with success, but no statistics have shown such extraordinary results from any particular line of treatment, that it has been universally adopted to the exclusion of all other measures. When the variation in the course of the disease and the different clinical histories are recalled, it hardly seems probable at the present moment that any such dramatic event is likely to occur.

Prevention affords the most hopeful solution, and this entails the laborious and accurate study of every aspect of osteomyelitis.
There are two schools of thought regarding the local operative treatment of osteomyelitis. There is one school with a firm conviction that favourable results are directly proportionate to the degree of conservatism - they maintain that the less extensive operations are without doubt the operations of choice.

On the other hand there is a school which insists that exposure of the medulla to the fullest extent is of the greatest importance, and they regard methods such as the Multiple Drill of Starr as inadequate and unsatisfactory.

Unfortunately, the problem of treatment is not straightforward and the possible factors are so closely interwoven, that it is very difficult to single out one in particular.

The discovery and application of maggots in the treatment of osteomyelitis, has inaugurated a wave of optimism even in the minds of a most conservative profession, particularly in America. While this hopefulness as yet may be said to have at best a very slender foundation in fact, there is no doubt that the increasing prominence which is being given to the facts regarding this treatment will ultimately yield a fruitful return.
Two aspects of this problem are of distinct importance, namely, the economic and the humane. The possible chronicity of the disease with the multiple operations and chronic invalidism consequent upon it is of grave financial import to the young adult worker striving to make his way in the world. Also, there is a distinct calamity in the case of a young child handicapped at the commencement of his adventure into life by frequent operations in association with confinement to bed and inability to grow and develop in health, strength and mind by being deprived of the companionship of his fellows and their multifarious activities.

The dominant feature in the treatment of acute osteomyelitis is that cases diagnosed sufficiently early, and treated properly, have a good prospect of cure, in other words, the difficulties and dangers in relation to this subject are rather those of sound judgment and capable diagnosis than of the various modes of operative interference.

It is to be hoped that in the future the profession will succeed in establishing - a method with 100 per cent. cure and no recurrences - by the production of evidence that will satisfy all who are looking for a real advance in the treatment of osteomyelitis.
CONCLUSIONS

(1) That osteomyelitis is in most cases primarily a disease of the metaphyseal region of the long bones.

(2) That there is frequently a history of trauma, and pre-existing septic foci; but in many cases it may be impossible to trace the real origin of the infection.

(3) That the systemic and local manifestations of the disease vary within wide limits, and such variation is not wholly dependent on the nature of the causal organism.

(4) That pyogenic metastases occur.

(5) That two forms of the disease may be recognised, one in which the general systemic disturbance is predominant, and the other in which the local manifestation constitutes the major feature.

The methods of treatment applicable in any case, and the prognosis of the case, differ in these two types.

(6) The treatment of the local lesion is of secondary importance to the measures adopted
to combat the systemic disturbance and where these are marked only minimal local measures are advocated.

(7) That it is doubtful if osteomyelitis is ever completely cured; recrudescence may occur after many years.

(8) No matter how prompt and how successful the treatment may be, recovery is slow, and healing long delayed.

(9) That improvement of immediate mortality statistics will be improved not by improved local operative technique, but by the introduction of measures capable of combating more effectively the general septicaemia.

(10) Education of the general public, better general hygiene of the skin, and improved diet are necessary if we are to hope for eradication of the disease or the train of sequelae.
STATISTICS.

(IN DETAILED & SUMMARISED FORMS).

NEW CASES of OSTEOMYELITIS.

WARDS 7 & 8.

YEARS 1925 to 1931.

(April 1st, 1925, to March 31st, 1931).
For the purpose of giving a comprehensible summary of the treatment in statistical form, what appears to have been the major or main treatment has been selected in each case. This does not preclude the fact that other operative treatment has also been given - e.g. Incision and Drainage + Sequestrectomy; Sequestrectomy + Saucerisation.
NEW CASES of OSTEOMYELITIS.

<table>
<thead>
<tr>
<th>Case Number</th>
<th>Male</th>
<th>Female</th>
<th>Age</th>
<th>Bones Affected</th>
<th>Treatment (Main)</th>
<th>Infecting Organism</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Incision &amp; Drainage</td>
<td>Staphylococcus Aureus,</td>
<td>Cured</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pneumococcus,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Not given.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Staphylococcus Aureus</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pneumococcus,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Not given.</td>
<td></td>
</tr>
</tbody>
</table>

NOTE. Case A633 omitted from this series, as the patient (a male) was discharged after 3 days by disappearance of suspicious symptoms.

1925 to 1926.
**NEW CASES of OSTEOMYELITIS.**

**WARDS 7 & 8.**

<table>
<thead>
<tr>
<th>Case Number.</th>
<th>(April 1st, 1927, to March 31st, 1928).</th>
</tr>
</thead>
<tbody>
<tr>
<td>C745</td>
<td>1</td>
</tr>
<tr>
<td>Male.</td>
<td>1</td>
</tr>
<tr>
<td>Female.</td>
<td>1</td>
</tr>
<tr>
<td>Age.</td>
<td>13 30 16 19.6</td>
</tr>
<tr>
<td>Average Age.</td>
<td>16</td>
</tr>
<tr>
<td>Bones affected:</td>
<td>Femur, 1</td>
</tr>
<tr>
<td></td>
<td>Tibiae, (bi-lateral) 1</td>
</tr>
<tr>
<td>Treatment (Main):</td>
<td>(In 1 case)</td>
</tr>
<tr>
<td></td>
<td>2 (Carrel Dakin drainage) 1</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>S. Staphylococcus.</td>
<td>1</td>
</tr>
<tr>
<td>Infection Organism:</td>
<td>Staphylococcus.</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Results.</td>
<td>Improved.</td>
</tr>
<tr>
<td></td>
<td>Cured.</td>
</tr>
<tr>
<td></td>
<td>Improved.</td>
</tr>
</tbody>
</table>

**(a) Wassermann test, 1 positive, 1 negative.**

**NOTE:** 1 additional case sent to another Ward for treatment.

**1 additional case.**
NEW CASES OF OSTEOMYELITIS.

(April 1st, 1928, to 31st March 1929).

<table>
<thead>
<tr>
<th>Case Number</th>
<th>Male</th>
<th>Female</th>
<th>Average Age</th>
<th>Femur</th>
<th>Tibia</th>
<th>Pubic Bone</th>
<th>Descending Ram</th>
<th>4 Improved</th>
<th>2 Sterile</th>
<th>3 Not Sterile</th>
<th>1 Staph. + Gram: +</th>
<th>1 Staph. + Gram: -</th>
<th>3 Staph. -</th>
<th>1 Amnond</th>
<th>1 Staph. + Gram: -</th>
<th>1(0) Staph. + Gram: +</th>
<th>3 Staph. = Staphylococcus Aureus</th>
<th>1 Cure</th>
<th>1(0) Improved</th>
<th>1(0) Not given</th>
<th>2(0) Sterile</th>
<th>5(0) Cured</th>
<th>4(0) Improved</th>
</tr>
</thead>
<tbody>
<tr>
<td>D784</td>
<td></td>
<td></td>
<td>18.6</td>
<td></td>
<td></td>
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<td></td>
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<td>0</td>
<td>0</td>
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</tr>
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<td>D966</td>
<td></td>
<td></td>
<td>18.4</td>
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<td></td>
<td></td>
<td></td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
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</tr>
<tr>
<td>D978</td>
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<td></td>
<td>19.8</td>
<td></td>
<td></td>
<td></td>
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</tr>
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<td>E117</td>
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<td>16.0</td>
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<td>0</td>
<td>0</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E146</td>
<td></td>
<td></td>
<td>19.4</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>E21</td>
<td></td>
<td></td>
<td>19.2</td>
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<td>1</td>
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<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>8</td>
<td>8</td>
<td></td>
<td>14</td>
<td>18</td>
<td>18</td>
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<td>19</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**NEW CASES OF OSTEOMYELITIS.**

<table>
<thead>
<tr>
<th>Age</th>
<th>Male</th>
<th>Female</th>
<th>Affected Bones</th>
</tr>
</thead>
<tbody>
<tr>
<td>26-8 Av.</td>
<td>18</td>
<td>3</td>
<td>Femur, Tibia, Fibula, Calcaneus, Metatarsal, Rib &amp; Clavicle, Scapula, Femur, Tibia, Fibula</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Result</th>
<th>Died</th>
<th>Improved</th>
<th>Not Eval.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staphylococcus aureus</td>
<td>4</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Infection Site</th>
<th>Male</th>
<th>Female</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femur</td>
<td>3</td>
<td>1</td>
<td>Incision &amp; Drainage, Curettage</td>
</tr>
<tr>
<td>Tibia</td>
<td>1</td>
<td>1</td>
<td>Diaphysectomy, Periosteotomy, Saucerisation &amp; Drainage</td>
</tr>
<tr>
<td>Fibula</td>
<td>1</td>
<td>1</td>
<td>Amputation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Infection Site</th>
<th>Male</th>
<th>Female</th>
<th>Treatment (Main)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rib &amp; Clavicle</td>
<td>1</td>
<td>1</td>
<td>Amputation, Drainage</td>
</tr>
<tr>
<td>Metatarsal</td>
<td>1</td>
<td>1</td>
<td>Saucerisation &amp; Drainage</td>
</tr>
<tr>
<td>Calcaneus</td>
<td>1</td>
<td>1</td>
<td>Sequestrectomy</td>
</tr>
<tr>
<td>Femur</td>
<td>1</td>
<td>1</td>
<td>Diaphysectomy</td>
</tr>
<tr>
<td>Tibia</td>
<td>1</td>
<td>1</td>
<td>Curettage</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Followed by plaster, O.R.</th>
<th>1</th>
<th>1</th>
</tr>
</thead>
</table>

**Notes:**
- Staphylococcus aureus given.
- Improved.
- Died.

**Wards:** 7 & 8.

*April lst. 1930, to March 31st, 1931.*
1925 to 1926.

SUMMARY.

NEW CASES of OSTEOMYELITIS.

WARDS 7 & 8.

(April 1st, 1925, to March 31st, 1926).

<table>
<thead>
<tr>
<th>CASES</th>
<th>MALE</th>
<th>FEMALE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

AVERAGE AGE. 29.4

BONES AFFECTED.
1 Femur,
2 Tibiae,
1 Humerus,
1 Metatarsal (1st) Right foot.

MAIN TREATMENT.
3 Incision and Drainage.
2 Sequestrectomy(& Incision & Drainage).

INFECTING ORGANISM.
1 Staphylococcus Aureus,
1 Pneumococcus,
3 Not given.

RESULTS.
4 Cured.
1 Improved.
SUMMARY.

NEW CASES of OSTEOMYELITIS.

WARDS 7 & 8.

(April 1st, 1926, to March 31st, 1927).

<table>
<thead>
<tr>
<th>CASES</th>
<th>MALE</th>
<th>FEMALE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>4</td>
<td>14</td>
<td></td>
</tr>
</tbody>
</table>

AVERAGE AGE. 22.78

BONES AFFECTED.

7 Femur.
1 Ilium.
1 Humerus.
1 Fibula.
2 Jaw, (lower).
1 Thumb.
1 Metatarsal (1st).

MAIN TREATMENT.

10 Incision & Drainage. (1 Carrel Dakin)
2 Sequestrectomy.
1 Amputation (Metatarsal case)
   (Teale's, modified).

INFECTING ORGANISM.

5 Staphylococcus Aureus (In 1 case plus a few chains Streptococcus)
2 Streptococcus.
1 Non-haemolytic Streptococcus plus Staphylococcus Albus.
5 Not given.
1 ? Teeth infection. Later developed t.b. kyphotic spine. Sent to San.

RESULTS.

7 Cured.
4 Improved.
3 Died.
1927 to 1928.

SUMMARY.

NEW CASES of OSTEOMYELITIS.

WARDS 7 & 8.

(April 1st, 1927, to March 31st, 1928).

CASES. MALE. FEMALE. TOTAL.

3 - 3

AVERAGE AGE. 19.6

BONES AFFECTED.

1 Femur (with abscess in Femoral region)
1 Tibia (bi-lateral)
1 Toe, great (with Cellulitis)

MAIN TREATMENT.

2 Sequestrectomy & Drainage, (In 1 case Carrel Dakin drainage).
1 Saucerisation & Insertion of Muscle Graft, (Right & Left).

INFECTING ORGANISM.

2 Staphylococcus.

NOTE. In 3rd case, Wassermann test, 1 positive, 1 negative.

RESULTS.

2 Cured.
1 Improved.

NOTE.

1 Additional Case admitted this period, but sent to another Ward for treatment.
1928 to 1929.

SUMMARY.

NEW CASES of OSTEOMYELITIS.

WARDS 7 & 8.

(April 1st, 1928, to March 31st, 1929).

<table>
<thead>
<tr>
<th>CASES</th>
<th>MALE</th>
<th>FEMALE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>1</td>
<td></td>
<td>9</td>
</tr>
</tbody>
</table>

AVERAGE AGE. 18.6

BONES AFFECTED.

4 Femur.
4 Tibia.
1 Pubis, (Descending Ramus).

MAIN TREATMENT.

3 Incision & Drainage.
2 Saucerisation.
3 Sequestrectomy.
1 Extension, (Wainwright's box, Pubis case.)

INFECTING ORGANISM.

3 Staphylococcus Aureus.(Plus a few chains of Streptococci in 1 case)
1 Staphylococcus plus Gram Negative & Gram Positive Diplococci).
2 Sterile ( of which 1 a blood culture only, as no pus available).
3 Not given.

RESULTS.

5 Cured. (a)
4 Improved.

NOTE.(a) In two of these cases, patients returned three months and six weeks later still complaining of pain. In one of these, Diathermy or ionization and iodine treatment was suggested.
NEW CASES OF OSTEOMYELITIS.

WARDS 7 & 8.

(April 1st, 1929 to March 31st, 1930).

CASES, MALE, FEMALE, TOTAL.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

AVERAGE AGE. 15.6

BONES AFFECTED.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Femur.</td>
</tr>
<tr>
<td>1</td>
<td>Ilium.</td>
</tr>
</tbody>
</table>

MAIN TREATMENT.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Incision &amp; Drainage.</td>
</tr>
<tr>
<td>1</td>
<td>Saucerisation.</td>
</tr>
<tr>
<td>1</td>
<td>Sequestrectomy.</td>
</tr>
</tbody>
</table>

INFECTING ORGANISM.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Staphylococcus.</td>
</tr>
<tr>
<td>2</td>
<td>Staphylococcus Aureus.</td>
</tr>
</tbody>
</table>

RESULTS.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cured.</td>
</tr>
<tr>
<td>1</td>
<td>Improved.</td>
</tr>
<tr>
<td>1</td>
<td>Died.</td>
</tr>
</tbody>
</table>
NEW CASES OF OSTEOMYELITIS.

WARDS 7 & 8.

(April 1st, 1930, to March 31st, 1931).

<table>
<thead>
<tr>
<th>CASES</th>
<th>MALE</th>
<th>FEMALE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>3</td>
<td></td>
<td>11</td>
</tr>
</tbody>
</table>

AVERAGE AGE. 26.8

BONES AFFECTED.

3 Femur,
3 Tibia,
1 Fibula,
1 Calcaneus,
1 Metatarsal, (Head of 1st Metatarsal).
1 Rib and Clavicle,
1 Scapula.

MAIN TREATMENT.

2 Incision & Drainage,
1 Curettage,
2 Diaphysectomy,
1 Periosteotomy,
2 Saucerisation,
2 Sequestrectomy (a)
1 Amputation.

INFECTING ORGANISM.

4 Staphylococcus,
4 Staphyloccocus Aureus.
3 Not given.

RESULTS.

6 Cured.
4 Improved.
1 Died.

NOTE (a).

In 1 case, followed by plaster, Orr's method.
Average Age
of Cases of Osteo-myelitis in Wards 7 and 8
The average age of New Cases of Osteomyelitis in Wards 7 and 8.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>AGE.</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>1925-1926</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>29.4</td>
</tr>
<tr>
<td>1926-1927</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>22.78</td>
</tr>
<tr>
<td>1927-1928</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td></td>
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<td>19.6</td>
</tr>
<tr>
<td>1928-1929</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18.6</td>
</tr>
<tr>
<td>1929-1930</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15.6</td>
</tr>
<tr>
<td>1930-1931</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>26.8</td>
</tr>
</tbody>
</table>

Average over period of six years 22.13
SEX INCIDENCE
of Cases of Osteomyelitis
in Wards 7 and 8.
(April 1st 1925 to March 31st 1931)

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>1925-1926</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>1926-1927</td>
<td>10</td>
<td>4</td>
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<tr>
<td>1927-1928</td>
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<tr>
<td>1928-1929</td>
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<tr>
<td>1929-1930</td>
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<td></td>
</tr>
<tr>
<td>1930-1931</td>
<td>8</td>
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<tr>
<td><strong>Total</strong></td>
<td>36</td>
<td>9</td>
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</tbody>
</table>

Total 45.
## SUMMARY of BONES AFFECTED
### IN CASES OF OSTEOMYELITIS

**Wards 7 and 8**

<table>
<thead>
<tr>
<th>Bone</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femur</td>
<td>18</td>
</tr>
<tr>
<td>Tibia</td>
<td>10</td>
</tr>
<tr>
<td>Metatarsal</td>
<td>3</td>
</tr>
<tr>
<td>Humerus</td>
<td>2</td>
</tr>
<tr>
<td>Ilium</td>
<td>2</td>
</tr>
<tr>
<td>Fibula</td>
<td>2</td>
</tr>
<tr>
<td>Jaw (lower)</td>
<td>2</td>
</tr>
<tr>
<td>Thumb</td>
<td>1</td>
</tr>
<tr>
<td>Toe</td>
<td>1</td>
</tr>
<tr>
<td>Pubis</td>
<td>1</td>
</tr>
<tr>
<td>Calcaneous</td>
<td>1</td>
</tr>
<tr>
<td>Rib and Clavicle</td>
<td>1</td>
</tr>
<tr>
<td>Scapula</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>45</td>
</tr>
</tbody>
</table>
SUMMARY of BONES AFFECTED
In Cases of Osteomyelitis
Between the ages of 5 and 20 years.
Wards 7 and 8.

<table>
<thead>
<tr>
<th>Bone</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femur</td>
<td>14</td>
</tr>
<tr>
<td>Tibia</td>
<td>4</td>
</tr>
<tr>
<td>Jaw (lower)</td>
<td>2</td>
</tr>
<tr>
<td>Metatarsal</td>
<td>1</td>
</tr>
<tr>
<td>Ilium</td>
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</tr>
<tr>
<td>Great Toe</td>
<td>1</td>
</tr>
<tr>
<td>Scapula</td>
<td>1</td>
</tr>
<tr>
<td>Fibula</td>
<td>1</td>
</tr>
<tr>
<td>Rib and Clavicle</td>
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</tbody>
</table>

Total: 26
INFECTING ORGANISMS

Found in Cases of Osteomyelitis
Wards 7 and 8

<table>
<thead>
<tr>
<th>Organism</th>
<th>Count</th>
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</thead>
<tbody>
<tr>
<td>Staphylococcus Aureus</td>
<td>23</td>
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<tr>
<td>Streptococcus</td>
<td>3</td>
</tr>
<tr>
<td>Sterile</td>
<td>2</td>
</tr>
<tr>
<td>Pneumococcus</td>
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</tr>
<tr>
<td>Not given</td>
<td>16</td>
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</tbody>
</table>

45