AN ENQUIRY INTO THE OCCURRENCE OF URINARY LITHIASIS IN PATIENTS SUFFERING FROM TUBERCULOSIS OF BONES AND JOINTS.

A thesis for the Degree of M.D. (Glas.)

presented by

MARY G. GORRIE, M.B.,Ch.B.(Glas.) D.H.P.(Glas.)

I wish to express my sincere thanks to Mr. E.D. Telford, Manchester University, for his suggestions and help in referring to me the three cases of stone - to Dr. D.P. Cuthbertson, Glasgow University, for information regarding technique, and for affording me facilities for case taking and laboratory work to Mr. G.D. Dawson, Pathology Dept., Crumpsall Institute, and Drs. J.E. Geddes and W.S. Murray, Manchester Sanatorium, Abergele.

AN ENQUIRY INTO THE OCCURRENCE OF URINARY LITHIASIS IN PATIENTS SUFFERING FROM TUBERCULOSIS OF BONES AND JOINTS

These surgeons who have charge of large numbers of cases of non-pulmonary tuberculosis in orthopaedic hospitals and sanatoria have been accustomed to note that these patients show an incidence of urinary lithiasis beyond the normal. The condition is often singularly silent and the first sign of stone formation may be the appearance of a shadow in the routine radiogram. It is not possible to indicate in figures just how high the incidence is, but it is certainly considerably above that found in the general population. A review of the available literature of the condition brings out two important points. First, the lithiasis is by no means confined to tuberculosis; it has been described in cases of injury to the spine or hip and in some cases of paralysis. It is thus evident that tuberculosis per se is not a causal agent and that the explanation must be sought in some factor which arises during treatment. The second point is that a number of the recorded cases are by no means free from the suspicion that urinary sepsis led, as it so commonly does, to the lithiasis. Cases of this type should be rigorously excluded from the enquiry, which is concerned only with aseptic "metabolic"

stones, existing without clinical evidence of urinary sepsis.

In 1891, Hoppe Seyler comments on the well-known fact that bones atrophy when their muscles are paralysed. He refers to Quincke's case, a girl, aged 8 years, long bedfast with spondylitis, who had a spontaneous fracture of the femur, was given calcium as treatment and passed two stones per urethram. On analysis these stones proved to be phosphate and carbonate of lime. Similar stones being described in other cases by the same writer, Hoppe Seyler proceeded to examine the calcium content of the urine in bed-ridden cases, with daily controls with up-patients on the same diet. He found that rest increased the calcium output, especially in the young, and that the only exceptions he found were due to old age or great loss of appetite. This calcium was presumably derived from the bones. Hoppe Seyler states, further, that the calcium output shows signs of becoming gradually less as time goes on, and he suggests that a state of equilibrium is reached.

In 1895, Muller describes ten cases in patients with fractured spine after recumbency of three months and upwards. He discusses decubitus, but does not regard it as a cause. He does not suggest decalcification of bone, but thinks that stone is the result of lesion of the spinal cord.

The nervous theory of Muller is again mentioned in

1924, when Bliss, Livermore and Ellsworth report on stones being formed frequently in the kidneys following injury to the spinal cord, and suggest that this may be due to nervous derangement. The same writers go on to theorise on calculus formation following fractures of the spine and hip in elderly people. These may be due to disturbance of calcium metabolism, or is the excess calcium in the blood for repair of the fracture excreted in the urine, and do the inflammatory products of fracture upset the colloidal balance in the urine, with resulting precipitation of colloids and crystalloids and consequent calcium calculi in the kidneys? This introduces the factor of local damage to the urinary tract, or, at any rate, points to changes in the urine other than alterations of mineral content.

Any investigation into calculus formation must take account of the observations which have been made on its relation to diet and "deficiency" diseases.

In 1917, Osborne and Mendel probably first suggested that stone is a deficiency disease. They reported 81 rats having stone, out of a total 857 cases examined. 35.43% of these 81 had never had any source of fat-soluble vitamin. The remainder had had none during the experiment.

In 1926 Fujimaki reported phosphatic calculi in bladder and kidney, and cholesterol in bile ducts of rats after long feeding with A-deficient or A and C deficient diets. Vitamin B as a cause of stone was ruled out.

In 1927 McCarrison performed a number of experiments on rats, feeding them on a relatively low animal protein and deficient vitamin A (probably also deficient vitamin D). The stones found contained calcium and magnesium phosphate and calcium oxalate. His conclusion was that four factors were of importance:

1 Deficient vitamin A
2 Absence of animal protein
3 Richness of earthy phosphate
4 Possible toxic action of diet on urinary tract.

His conclusions were later criticised by Joly and in part supported by Gudjousson and Gasparjin and Outschinnikov. The two last state that phosphatic calculi predominate in that portion of the population in whom diet is most apt to contain few vitamins, especially an absence of vitamin A.

Though Ranganathan (1931) blames entirely an ill-balance in the diet of calcium and phosphorus, his co-worker, McCarrison, in a second series of experiments in 1931, postulates the theory of two positive and two negative factors:

Positive	1	Excess vitamin D
	2	Excess calcium
Negative	1	Deficient vitamin A
	2	Deficient phosphorus

It is very unlikely that any explanation based on deficiency would hold good for cases under a generous diet and anti-tuberculous regime in a sanatorium, but it is

different with the possible excess of vitamin D. Some observers (notably Pugh) attribute stone formation to excessive heliotherapy. This might conceivably act by too great production of vitamin D, or, as some think, by inducing too great an activity of the sweat mechanism. The latter have prescribed a large fluid intake during heliotherapy as a prophylactic measure.

We have then to consider two possible explanations:

1 The effect of very prolonged recumbency in producing decalcification of bone, which calcium must either be excreted or deposited in other parts,

2 The effect of an excess of vitamin D.

The second of these appears to be less convincing as an explanation. In the Manchester Corporation Sanatorium at Abergele there are constantly some 110 cases of non-pulmonary tuberculosis who are almost without exception treated with prolonged recumbent fixation. In adjoining wards are 100 cases of early pulmonary or "pre-tuberculous" disease. Both classes are children up to 16 years of age. Both live under identical conditions as regards light, air and diet; the one and only difference is the lack of exercise in the non-pulmonary cases.

During the past three years, no instance of stone has occurred in the pulmonary cases, but several examples of renal symptoms and X-ray shadows have occurred in the recumbent cases. Such results would seem to be against the

vitamin theory and on the material available as above described, appeared to be so favourable to a test of the theory that stone formation results from decalcification of bone consequent on disease, it is to this aspect of the question that this enquiry is directed.

There is abundant ground on which to base the opinion that decalcification of bone is a likely cause of renal stone. Such happens not infrequently in osteitis fibrosa in some cases of which not only is renal calculus formed, but also calcification of lungs, pericardium and heart muscle. A similar happening is found in osteo malacia and museums contain osteo malacic skeletons showing large calculi derived from the kidneys.

There appears then good ground for the enquiry which I have carried out on the following lines:

1 A general survey of the renal condition of 61 children between the ages of 5 years and 15 years.

2 An analysis of stones found.

3 An observation on serum calcium in a group of 15 recumbent cases, over a year, at quarterly intervals, together with a series of X-ray photographs of the diseased parts.

4 An observation on the urinary output of calcium, in relation to the comparative density of the long bones in 10 recumbent cases and controls - based on a metabolic

period of 8 days with constant average diet, and estimation of blood, urinary and faecal calcium.

REFERENCES.

Bliss, Livermore & Ellsworth - Report of U.S.P.H. Service 1910. Journal Urology, Vol. 30,1. 1924.

Fujiwaki - see M^C^Carrison.

Gaspargan and Cutshinnikov - Zeit. fur Urol. Chirurg. Oct. 1930. 365-374.

Gudjousson - Acton. Path. Microbiol. Scand. 1930.

Hoppe-Seyler, G. "Uber die Aussheidung der Kalksalze in Urin etc. Ztschr. f. Physiol. chem. 15, 161. 1891.

Mueller, K. "Uber nephrolithiasis nach Rückenmarksverletzungen". Arch. f. Klin. Chir. 50, 601. 1895.

M^C^Carrison - Causation of stone in India. B.M.J. June 13, 1931.

Pugh, Carshalton - B.M.J. 1936.

Ranganathan. Indian J. Med. Research, 19, 1-47. 1931.

TECHNIQUE

I A general survey of urinary findings was made in 35 recumbent cases and 26 ambulant.

The urine was examined for normal and abnormal constituents. The usual laboratory routine was employed

Specific gravity		
Acidity		
Albumen	-	heat and acetic acid test
Sugar	-	Benedict's test
Pus	)	
Blood	)	microscopic examination.
Crystalline or other Sediment	)	

II. Analysis of urinary calculi - according to Heller's table - on heating powder on

Burns	Without flame				No noticeable ammonia reaction.	Uric acid.
					Strong ammonia reaction.	Ammonium urate.
					Does not give murexide test. Powder dissolves in HKO_3 without effervescence. Dried yellow residue becomes orange with alkali, beautiful old with warming.	Xanthin.
	With flame				Flame pale blue burns a short time. Peculiar sharp odour. Powder dissolves in ammonia and six-sided plates separate on the spontaneous evaporation of the ammonia.	Cystine.
					Flame, yellow, pale, continuous. Odour of resin or shellac on burning. Powder soluble in alcohol and ether.	Urostealith.
					Flame yellow, continuous, odour of burnt feathers. Insoluble in alcohol and ether. Soluble in potassium hydroxide with heat.	Fibrin.
Does not burn	The powder when treated with HCL				Effervesces	Calcium Carbonate.
		Does not effervesce	Gently heated, then treated with H Cl		Effervesces	Calcium Oxalate.
				Moistened with KOH	No ammonia, or at least only traces. Powder dissolves in HA or HCL. This solution gives an amorphous precipitate with ammonia.	Magnesium and Calcium Phosphate.
					Abundant ammonia. Powder dissolves in HA or HCL. Solution gives a crystalline precipitate with ammonia.	Triple phosphate (mixed with unknown amount of earthy phosphate.)

III ESTIMATION OF BLOOD CALCIUM.

Method of Kramer and Tisdall.

Materials

Sol. saturated ammonium oxalate
Ammonia conc.

$\frac{N}{1}$ Sulphuric acid

$\frac{N}{10}$ Sodium oxalate

Crystals potassium permanganate

Apparatus

Centrifuge tubes 15 c.c. graduated
Centrifuge 1,500 revs. per minute
Capillary pipette with upturned end
burette graduated 0.02 c.c.
Water bath
Syringes, needles, etc.

Method

Approximately 8 c.c. blood withdrawn from a vein into a dry sterilised needle and syringe. This is allowed to clot. The clot is separated from the sides of the tube and the tube put into centrifuge at 1,500 revolutions per minute.
2 c.c. serum is put into 15 c.c. tube with 2 c.c. water. 1 c.c. saturated ammonium oxalate is added.
The whole is mixed by tapping end of tube with finger and allowed to stand for at least ½ hour, when it is again mixed and put in centrifuge for 5 minutes.
Supernatant fluid is decanted or withdrawn with pipette and 2% ammonia added to 4 c.c., so as to wash down sides of tube (all but 0.3 c.c. decanted at each washing).

Fluid is mixed and again centrifuged.
This constitutes one washing.
Supernatant fluid is decanted as before
and two more washings performed.
The precipitate (calcium oxalate) is
now dissolved in 2 c.c. $\frac{N}{1}$ sulphuric
acid and heated in boiling bath for
several minutes.
While still hot, titrate with
$\frac{N}{100}$ $KMnO_4$ till pink colour persists
one minute.

Calculation

1 c.c. $\frac{N}{100}$ $KMnO_4$ = .0002 gm. Ca.

2 c.c. serum = X c.c. $\frac{N}{100}$ $KMnO_4$ (= .2 X mgm Ca).

$\therefore$ 100 c.c. serum = 100 X mgm. Ca.

IV ESTIMATION OF URINARY CALCIUM.

Method of Shohl and Pedley.

Materials: Conc. $H.NO_3$ or H_2SO_4
$\frac{N}{1}$ H_2SO_4
Ammonium persulphate
2.5% oxalic acid
Ammonium hydroxide
Methyl red.
Potassium permanganate .05 N.

Apparatus: Erlenmeyer flask
Hot plate
Pipettes 10 c.c.
Filter paper Whatman No. 50, hardened
12.5 cm.
Burette

Method: To 100 c.c. urine in a 250 c.c. Erlenmeyer flask add 5 c.c. Conc. $H.NO_3$ or H_2SO_4 and one spoonful containing 3-4 gms ammonium persulphate.
Insert a funnel in the flask to prevent spattering. Boil and keep near the boiling point on a hot plate over a low flame for one hour, or until reduction of the persulphate is complete, as evidenced by absence of colour.
Add 10 c.c. of 2.5% oxalic acid.
Cool to room temperature. Neutralise with ammonium hydroxide, using one drop of methyl red as indicator.
Cool to room temperature.
If the colour is now red, add a few drops of ammonia to bring to immediate colour between red and yellow (pH 4.8 - 5.2)
Allow to stand overnight.
Filter with Whatman No. 50 hardened paper (12.5 c.m).
Wash precipitate and flask three times with distilled water, filling the filter 2/3 full each time and allowing to drain.
Break a hole in the filter paper and wash back the precipitate into the original flask, first with distilled water and then with hot dilute sulphuric acid, bringing the volume to about 100 c.c.
Add 10 c.c. of concentrated sulphuric acid.
Heat to 70-80°C.
Titrate with 0.05 N $KMnO_4$, taking as end point the first colour that persists 15-30 secs.

Principle: The urine is oxidised with ammonium persulphate. Calcium is precipitated as oxalate and titrated with potassium permanganate.

Calculation: 1 c.c. 0.05/N $KMnO_4$ = 0.0010 gm Ca.
0.0014 gm CaO.

IV ESTIMATION OF CALCIUM IN ASH OF FOOD OR FAECES.

Method of McCrudden.

Ignite the material in a platinum crucible to a white ash (800°C) and dissolve the ash with the aid of a little hydrochloric acid. Bring the volume of the ash solution to 75 - 150 c.c. Make just alkaline with strong ammonia, added drop by drop (using litmus paper or alizarin red as indicator). Add conc. HCl drop by drop until just acid to litmus. Then add 10 drops conc. HCl (5p.gr 1.20) and 10 c.c. of 25 oxalic acid. Add 8 c.c. of 20 sodium acetate solution (in ash of faeces, 15 c.c.). Allow to stand overnight.
Filter off the calcium oxalate on a small ash free paper and wash free from chlorides with 0.5 ammonium oxalate solution.
Wash the precipitate three times with cold distilled water, as under method for urine, and titrate the oxalate with potassium permanganate.

1 c.c. 0.05 N $KMnO_4$ = 0.001 gm Ca.

V X-RAY EXAMINATION.

Several X-ray photographs were taken of the recumbent cases, in order to gain an estimate of the process going on in the diseased part - calcification or osteoporosis.
During the metabolic period, 10 cases were chosen and, as far as possible, controls of approximately the same age and stature, and the same sex.
Photographs were taken of the itibae of each pair with identical M.A.,K.V., and exposure, and these were incorporated side by side on one film.

CASE 10. J.P. male.

Age: $7\frac{4}{12}$ years.

Family history: No contact.

Past history: No previous illnesses.

History of complaint: Onset November 1935. Patient had fall and twisted right leg. Four weeks later limp developed, no pain.

December 1935. Admitted Booth Hall Hospital.

June 1936. Transferred to Abergele Sanatorium.

X-ray: "Erosion of upper part of right acetabulum which has allowed partial dislocation of right femur. Head and neck of right femur very osteoporotic, but shape of head still maintained."

X-ray: August.

"Abscess under posterior aspect of thigh."

Tuberculin: $\frac{1}{10,000}$ H. I
B. III.

VI MANAGEMENT OF THE METABOLIC PERIOD.

The diet chosen was one which contained the average amount of calcium given to these patients. It was constituted as follows, per diem -

Milk	630 c.c.
Brown bread	75.9 g.
Butter	65 g.
Dried apples	15 g.
Egg	15 g.
Sugar	5 g.
Mutton	30 g.
Carrot	10 g.
Orange	1
Oatmeal	2 tesp.
Potato	2 ozs.

This was given constantly over a period of 8 days. No collection of excreta was made during the first 3 days.

The faeces were measured off with carmine swallowed before breakfast at the commencement of the first day of collection, and a second dose of carmine was swallowed before breakfast on the last day of collection. Collection of faeces was arranged to include the first red portion and all passed subsequently until, and excluding the second red portion.

The urine was collected in 24 hour lots and preserved with thymol in chloroform. The bladder was emptied before breakfast on the first day of the period, and this portion rejected. The collection was continued until just before breakfast on the ninth day.

SECTION I.

SECTION 1.

A general survey of the renal condition of 61 children between the ages of 5 years and 15 years.

	Bone and Joint Disease					Tuberculosis of Other Organs					
	Spine	Hip	Knee	Ankle	Phalange	Pulmonary Hilar	Pulmonary Adult	Renal	Intestine	Skin	Glands
Total Cases examined	18	10	5	1	1	2	12	2	7	1	2
History of Nephritis	-	1	-	-	-	-	-	-	-	-	-
Pyuria	1	1	-	-	-	-	-	1	-	-	-
Haematuria	1	1	-	-	-	-	-	-	-	-	-
Albuminuria	2	-	1	-	-	-	-	1	-	-	-
X-ray Path.Shadow Kidney	-	-	-	-	-	-	-	1	-	-	-
Ureter	-	2	-	-	-	-	-	1	-	-	-
Bladder	-	-	-	-	-	-	-	-	-	-	-
Urine Sp.gravity	1020	1016	1022	1012	1012	1015	1015	(1002 (1024	1014	1024	1014
Acid	17	8	5	1	1	2	10	2	7	-	2
" Alk.	1	1	-	-	-	-	-	-	-	-	-
" Neut.	-	1	-	-	-	-	2	-	-	-	-
Albumin	8	4	1	1	-	-	-	2	-	-	-
Casts	-	1	-	-	-	-	-	1	1	-	-
Leucocytes	-	-	-	-	-	-	3	-	-	-	-
Polyhedral Cells	3o	-	-	-	1	-	-	-	-	-	-
Epithelial Debris	6♀ 3♂	2	1	1	-	-	-	-	1	-	-
Epithelial Cells	-	-	-	-	1	-	7	1	-	-	1
Oxalate Crystals	6	3	17	1	-	1	1	-	1	1	-
Phosphate "	4	4	1	-	1	-	4	-	3	-	1
Uric acid	-	-	1	-	-	-	-	-	-	-	-
Coliform Bacilluria	3	1	1	-	-	-	-	-	-	-	-
Tubercule Bacilluria	-	-	-	-	-	-	-	1	-	-	-

SUMMARY:

There was no renal, ureteric or bladder shadow in an "Other Organ" case. One patient showed a renal and ureteric shadow, where the focus was in the Kidney itself. The other two cases, with ureteric shadows, were bone and joint cases.

Of 9 children presenting a history of renal symptoms, 7 were patients suffering from bone and joint disease, 2 had tuberculous lesions in the Kidney itself, the rest of the "Other Organs" cases had no symptoms.

Of 31 cases showing abnormal cell content, 17 of these were from bone and joint cases.

With the exception of tuberculous bacilluria in one case of renal tuberculosis, there were no bacilli found in any of the "other organ" cases, while 3 children with bone and joint tubercle had coliform bacilluria.

Albuminuria was only present in bone and joint and in renal cases.

Phosphatic crystals occurred with equal proportion in both groups.

Oxalate crystals occurred in 15 cases, of which 11 were bone and joint cases.

Uric acid crystals were only found in one case of Knee joint disease.

The specific gravity of these urines was higher in the bone group than in the other, as 1018 : 1014.

There was hyper acidity of all urines.

These facts show that in the recumbent bone and joint cases in Abergele Sanatorium, there was

1. A higher incidence of renal symptoms.
2. A higher incidence of renal X-ray shadow.
3. A greater number of urines with crystalline deposit.
4. A greater incidence of organic abnormality in the urine.

For the purposes of this investigation, the last group may be discounted.

Bearing in mind the fact that crystalline deposit does not necessarily depend on the concentration of the mineral, it is nevertheless interesting that calcium is more or less constantly present in these deposits.

SECTION II.

SECTION 2.

AN ANALYSIS OF STONES FOUND.

Case A. Medical student.

Qualified Christmas 1930. Was seen with dorso-lumbar caries and lumbar abscess in May 1931. Was sent to Oswestry and kept strictly recumbent for 14 months. Did light work till August 1933, was then suffering from frequent micturition and pain in right loin.
X-ray showed small ureteric shadow.
Symptoms continued on and off till April 1934, when after intense colic he passed a stone.

Analysis of stone. Small, 2 cm X 1 cm, greyish, yellow, glistening, papillated, weight 3 grains.

Composition: Calcium and magnesium phosphate.
Uric acid.

Case B. G.W. aged 25. Bank Clerk.

Family history: No tubercle, contact to fellow clerk with P.T.

History: 1931 June - pain across back and down left leg, became worse.
1932 April - swelling left sacro-iliac joint.
May - admitted N.W. Sanatorium - abscess over left sacro-iliac.
X-ray showed definite disease.

Treatment - immobilised in plaster bed 1.6.32 - 15.2.34.

1933 March - M. Wilson Jones fusion by two grafts.
a) from 4-5 L.V. to sacrum
b) oblique from 4-5 L.V. to ilium.

Immobilised in plaster spica 15.2.34 to 12.3.34 in bed.

Immobilised in plaster spica 12.3.34 to 18.4.34 ambulant.

Sinuses over sacro-iliac and back of left thigh.

1934 April Mr. Hugh Reid. Removal of two vesical calculi, one size of golf ball, one size of large pea. These had been observed steadily growing in the series of X-rays.

May X-ray. 1. Left sacro-iliac fusing well, but graft from 4 L.V. absorbing rapidly.

2. Disease 4 L. disc.

3. Disease 10,11,12 D with abscess shadow.

Patient now ambulant in well-fitting plaster jacket.

Analysis of stone: Measured 3" X 3", roughly spherical, smooth, yellowish-white, chalky, weight 14 grains.

Composition: Calcium and magnesium phosphate.
Calcium oxalate (trace).

Case C. F.B. 13 years, Scholar.

Family history:

History: 1928 January - knocked over by cyclist, occasional pain in right hip.

April - Seen by Mr. Ollerenshaw. Plaster spica applied.

1931 December - admitted Abergele Sanatorium.
X-ray "Extensive old-standing disease of right hip joint "head of femur largely destroyed. Erosion of acetabulum, large calcified abscess". General condition unsatisfactory.

1933 March - treated M.R.I. for aural discharge

1934 June - urine loaded with albumen.

X-ray - calculus in left ureter.

September - Mr. Telford. Nephrectomy.
Lt. kidney tuberculous, enlarged and adherent.
Few small stones removed from ureter.

Analysis of stones - minute, white, hard.

Composition: triple phosphates.

uric acid (trace)

SIMILAR FINDINGS IN LITERATURE.

From time to time in the literature similar findings are described.

1891 Quincke's case, already referred to, produced a stone composed as follows -

Ca	28.2
PO_4	52.3
MgO	0.3
Other Salts	0.5

Other stones found by the same writer were composed of carbonate and phosphate of lime.

1920 Meyet describes two cases, one a boy aged 11 years, who, after 4 years immobilisation for Pott's disease, developed bilateral renal calculi. The second is that of a girl, aged 14 years, with tuberculosis of hip, who while immobilised in a plaster cast, had renal colic and passed a small stone.

1930 Borman reports bilateral renal and ureteral calculi in a boy of 9 years with osteomyelitis. His only symptom was haematuria, undiagnosed till autopsy.

1931 Weber collected 9 cases of nephrolithiasis following injury to the skeletal system.

Various writers have referred to the occurrence of calculus in cases of osteomalacia.

All mention the large calcium content of these stones and McCarrison in an analysis of all cases of urinary calculus in India, finds the chemical composition as follows:

Pure uric acid	6.6
" oxalate	5.7
" phosphate	1.32
Phosphate oxalate	10.1
Urate phosphate	8.8
Urate oxalate	34.5
Urate oxalate phosphate	32.7

Most Indian stones, he reports are composed mainly of calcium oxalate.

1933 Kahn and Rosenbloom analysed 24 calculi and found 60 with a calcium oxalate nucleus, 56 containing phosphate, all with a trace of uric acid, but only 3 with more than 10 .

Israel observed complete vertebral ankylosis with bilateral renal calculi.

Davies Colley writes

"Occurrence of stones in osteitis fibrosa system of interest-condition in bones not known to have any of the characteristics of an infection or to be complicated by stasis of primary infection of the urinary tract. Characterised by profound general decalcification of the skeleton, hypercalcaemia, metastatic calcification in lungs, stomach and kidneys, and demonstrable increase of calcium excretion in urine."

Barr and Charles writing on the relation of diseases of the bone to arterial calcification, and lithiasis, quote several cases, e.g. boy aged 16 years, with osteomyelitis of right knee, 18 months recumbent, blood calcium 8.8 mgms per 100 cc., with calcification of soft tissues and arteries and large irregular stone in pelvis of left kidney and few small stones in right pelvis - the stones seeming to consist entirely of calcium.

Wagner finds a case reported as early as 1837 - Olivier.

REFERENCES.

Barr, David P. and Charles, Cecil.

Libbman Univers. Vol.1, 155 ex seq.

Davies Colley, N.

"Bones and kidneys from a case of Osteomalacia in a girl aet. 13 years" Trans. Path. Soc. London, 35,285, 1884.

Israel, W. Zstr. f. Urol. 16. 321, 1922.

Kahn and Rosenbloom.

Jour. Amer. Med. Assoc. 59, 2252, 1933.

Meyet, M.H. Paris Chir. 12, 132. 1920.

Olivier. "Traite des maladies de la nivelle epiniere.

Tome 1, 498 - 1937.

Quincke. see Hoppe Seyler.

Weber, W. Ztschr. f. Urol. 25, 36. 1931

SECTION III.

SECTION 3.

An observation on serum calcium in cases recumbent from bone and joint disease.

Estimations were made at 3 monthly intervals over the year October 1933 - July 1934 inclusive.
As far as possible cases were chosen which showed fairly marked bony involvement, though at different stages of the disease.
X-ray films of the affected part were taken co-incidentally with the serum estimations.
Where a suitable control could be obtained, the serum calcium was there estimated.

The results were as follows:

GIRLS - age 5-15 years.

Case	Tuberculin reaction	Sediment rate	Condition				Serum Calcium-mg.per 100 cc.			
			General	Local	Stage	Bedfast	Oct.	Jan.	April	July
1.	1.1000 I	Slow	Good	Gross destruction	Sclerosis	3½ yrs.	-	8.3	12.0	10.0
1c.	1.1000 II	Fast	"				-	8.9	8.9	9.3
2.	1.100 II	V.fast	Poor	Gross bilateral	Osteoporosis	4 yrs.	6.8	3.3	8.0	6.0
3.	1.1000 I	Slow	Good	Gross destruction	Sclerosis	4 yrs.	9.4	9.8	10.4	9.6
4.c	1.1000 I	Fast	"					9.8		9.7
4.	1.1000 I	V.fast	Poor	Moderate dest.	Stationary	5 yrs.	13.0	8.0	10.7	8.7
5.	1.1000 I	V.fast	Fair	Gross destruction	Slow Sclerosis	4 yrs.	15.0	8.0	10.7	8.7

BOYS - age 5-10 years.

Case	Tuberculin reaction	Sediment rate	Condition				Serum Calcium-mg.p100 cc.			
			General	Local	Stage	Bedfast	Oct.	Jan.	April	July
6.	1.1000 I	Fast	Poor	Gross destruction	Slow sclerosis	3 yrs.	7.4	7.7	10.8	9.5
c.	1.10000 I	Moderate	Poor					9.2		9.6
7.	1.1000 IV	Fast	Poor	Gross destruction	Slow sclerosis	3½ yrs.	7.8	7.3	9.7	10.1
8.	1.1000 I	Fast	Fair	Gross destruction	Slow sclerosis	6 yrs.	-	-	9.0	9.4
c.	1.1000 II	Slow	Fair				-	-	-	10.3
9.	1.1000 IV	Slow	F.good	Moderate destruction	Sclerosis	4 yrs.	7.7	9.3	11.3	9.9
c.	1.1000 III	Fast	F.good				-	9.2	-	9.6
10.	1.1000 I	Moderate	F.good	Light destruction	Slow sclerosis	4½ yrs.	12.0	5.5	8.5	-
c.	1.100 IV	Slow	F.good				-	7.4	-	7.6
11.	1.1000 III	Fast	Poor	Gross destruction	Station-ary	4 yrs.	7.6	5.7	9.8	9.6

BOYS - age 10-15 years.

Case	Tuberculin reaction	Sedimentation rate	Condition				Serum Calcium-mg.p.100 cc.			
			General	Local	Stage	Bedfast	Oct.	Jan.	April	July
12.	1.100 I	Slow	Poor	Extensive destruction	Slow sclerosis	4 yrs.	8.4	9.2	10.0	11.4
13.	1.20 IV	Moderate	Fair	Extensive destruction	Advanced sclerosis	11 yrs.	15.0	22.4*	13.0	8.7
	1.1000 III	"	"				-	9.8	-	8.5
14.	1.100 II	Fast	Fair	Extensive destruction	Mod. sclerosis	4 yrs.	15.0	10.8	7.8	8.9
	1.10000 III	Slow	F.good				-	9.4	-	10.4
15.	1.000 II	Slow	F.good	Slight destruction	Slow sclerosis	2 yrs.	11.0	11.5	11.2	8.5
c.		Fast	" "					10.6	-	8.5

T. Tuberculin was given intradermally into the arm, in dilutions increasing from $\frac{1}{10,000}$ to 1/10. A positive reaction was graded I, II, III, IV according to its severity. I was most severe.

S. Sedimentation was estimated according to Cutler's graph.

* This figure was the result of three estimations. It was queried and repeated at the end of 1 week, when the figure was 14.2.

Study of figures - SECTION III - Blood Calcium in mgm. per 100 cc. - relation to other factors.

Age. Sex. Season.		Controls.	Cases.
GIRLS 5-15 years	Lowest reading	8.9	3.3
	Highest reading	9.8	12.0
	Average over all	9.4	9.3
	Average winter	9.3	7.5
	Average summer	9.45	9.0
BOYS 5-10 years	Lowest reading	7.4	5.5
	Highest reading	10.6	12.0
	Average over all	8.6	8.8
	Average winter	8.5	7.1
	Average summer	8.9	9.7
BOYS 10-15 years	Lowest reading	8.5	7.8
	Highest reading	10.6	22.4
	Average over all	9.5	11.1
	Average winter	9.9	13.5
	Average summer	9.1	9.4

In the Controls, the figures on the whole approximate to the lower level of adult serum calcium figures (9-11 mgm. per 100 cc.). The lowest figures occur in the group of Boys aet. 5-10 years, but disallowing one

exceptionally low figure - 7.4 - 7.6 - the average rises and approaches that of the other groups. Neither Sex nor Age therefore appear to have an important influence on blood-calcium.

There is no constant variation with the Season of the year.

In the Cases, there is again no positive conclusion with the factors age-sex-season, but there is a wider difference between individual readings and a greater deviation from the mean.

2. General Condition

		Controls		Cases
Good	(2)	9.4	(2)	9.9
Fairly good	(3)	8.8	(3)	9.6
Fair	(2)	9.5	(3)	12.6
Poor	(2)	8.8	(6)	8.6

On these figures there does not seem any ground on which to suggest a definite relation between blood serum calcium and the patient's general condition.

3. Tuberculin Reaction

		Controls		Cases
Mantoux positive $\frac{1}{10,000}$	(2)	9.6		-
" " $\frac{1}{1000}$	(4)	9.4	(11)	9.4
" " $\frac{1}{100}$	(1)	- 7.5	(3)	9.9
" " $\frac{1}{20}$		-	(1)	- 14.7

From these results, there is no evident relation between serum calcium level and sensitivity to Tuberculin.

4. Sedimentation Rate

			Controls.		Cases.
Cutler graph -	Slow fall	(2)	8.9	(5)	9.9
	Moderate	(3)	9.3	(2)	11.9
	Fast	(8)	9.5	(5)	9.1
	Very fast		-	(3)	8.9

No definite conclusions could be drawn from these average figures. A coincident investigation of sedimentation rates of all children in Sanatorum for the year 1933-34, bears out the absence of relation between sedimentation fall and progress of non-pulmonary cases.

4a. Length of time bedfast

2 + years	(1)	Serum calcium average	10.5
3 + "	(3)	" " "	9.2
4 + "	(8)	" " "	9.2
5 + "	(1)	" " "	10.1
6 + "	(1)	" " "	9.2
11 years	(1)	" " "	14.8

These figures do not show any special trend. Authorities writing on the subject point out that whereas there is a tendency to increased calcium loss in the very early stages of recumbency, this quickly reaches a state of

equilbrium. Unfortunately when this investigation was begun, there was no very early case in the Sanatorium.

5. Amount of local bony destruction.

Gross or extensive	(10)	Serum	calcium	average	9.8
Moderate	(2)	"	"	"	9.8
Slight	(2)	"	"	"	9.5

These averages come too closely together to point to any particular significance.

6. Degree of Sclerosis.

Osteoporosis		Serum	calcium	average	6.0
Stationary	(2)	"	"	"	9.1
Slow sclerosis	(7)	"	"	"	9.5
Active sclerosis	(3)	"	"	"	9.8
Advanced sclerosis		"	"	"	14.8

Conclusions: from these figures there is obviously great variation in the serum calcium in all cases.

In the Control Cases; considered as a whole,

1. The serum calcium appears higher in girls than in boys,
2. and higher in boys in the older age group.
3. In girls there is no variation between winter and summer.
4. The boys appear to have a lower reserve in summer.

In the Recumbent Cases, considered as a whole,

1. The serum calcium appears higher in girls than in boys at 5-15- years,
2. and higher in boys in the older age group.
3. There is no correlation with season.
4. There is no correlation with tuberculin reaction, or sedimentation graph.
5. There is no constant curve of improvement.

Taking individual cases:

No.
9. M.K., hip case, moderate damage, satisfactory sclerosis → Average Ca.

12. N.V., dorsal spine, considerable involvement, satisfactory sclerosis → Average Ca.

15. E.A., cervical spine, slight involvement, satisfactory sclerosis → Average Ca.

These three, at finish of observations, had fairly stable bone conditions - their calcium figure approximate most nearly to the normal.

On the other hand:

2. M.C., double hip case, extensive and active destruction, poor sclerosis → low and variable Ca.

7. W.D., hip and lumb. spine, marked destruction, improving poor sclerosis → low, improving Ca.

11. D.M.H., hip case, considerable destruction, improving sclerosis → low, improving Ca.

13. J.S., hip case, considerable destruction, marked sclerosis → high, falling Ca.

14. F.T., lumbar spine considerable destruction, active sclerosis → high, falling Ca.

10. E.F., whose X-ray film of Knee joint shows definite lines of arrested growth, gives a rising and falling blood calcium figure.

Considered as averages under the various headings, those under "degree of sclerosis" are the only figures which appear to show a definite trend, though on the whole there would appear to be a greater variation in the figures of the Cases as contrasted with the Controls. Under heading 6, active sclerosis would seem to be associated with a high blood reserve, which falls when calcium equilibrium is reached; and a state of marked bony destruction would seem to be accompanied by a low blood reserve.

But several objections are easily raised to these figures:

1) The terms "osteoporosis", "stationary" etc., are indefinite.
2) The number of cases varies in each group and the figures are not true averages.
3) None of the cases is of sufficiently recent onset to provide a contrast to the others.

LITERATURE.

Findings on this subject appear to be varied.
According to Virchow 1852, Pommer 1885, and Schmorl 1909, the serum calcium is usually low in osteomalacia.
Satonowski, 1925, found a rise in the blood calcium of dogs after fracture. Henderson, Noble and Sandiford, 1926 found the blood calcium normal. Moorhead found a slight variation - low figures with bony union and high with non-union.
D. P. Cuthbertson, 1930, who quotes the preceding authors, investigated the disturbances of metabolism produced by bony and non-bony injury and found little or no information from the blood calcium figures.
With regard to the effect of tuberculosis on the blood calcium, this appears to be slight. Popovicini found the blood calcium and phosphorus (in 54 patients) rising during the early stage and falling as the disease progressed or as cure took place.
Burckhardt pronounces Cod Liver Oil to have no effect on the blood calcium. Sunshine may cause a slight fall.

REFERENCES.

Burckhardt, E. Schweiz. Med. biochem. 1933. No. 3, 68-71.

Cuthbertson, D.P. Biochem. J. vol XXIV. No.4. pp. 1244-1263, 1932.

Popovicini, G. Rev. franc. de Pediat. 1934. 10, 624-629.

SECTION IV.

SECTION IV.

An observation on the urinary output of calcium, in relation to the comparative density of the long bones.

This was done in two groups.

In the first group, the excretory calcium was estimated and shown as percentage in urine and faeces. Accurate results were vitiated since it was discovered that some of the children had ingested more calcium than others, owing to additions on visiting day etc.

The second group was kept strictly to measured diet for a period of eight days, and these figures are the result of three separate estimations in each case.

GROUP I.

Case	A GL.	B FB.	C MR.	D WL.	E GH.	F MK.	G DMCH.	H HP.	I JS.	J FT.	K MB	L SM.
Sex	F	F	F	M	M	M	M	M	M	M	M	M
Age	6 yrs.	13 yrs.	14 yrs.	7 yrs.	7 yrs.	8 yrs.	9 yrs.	12 yrs.	13 yrs.	13 yrs.	14 yrs.	15 yrs.
Bedfast	$2\frac{1}{2}$ yrs.	6 yrs.	11 yrs.	3 yrs.	6 yrs.	4 yrs.	4 yrs.	$1\frac{1}{2}$ yrs.	11 yrs.	4 yrs.	2 yrs.	10 yrs.
Extent disease	Moderate	Extensive	Extensive	Gross	Gross	Gross	Gross	Mod.	Gross	Extens.	Slight	Gross
Stage disease	Calcific^{n}	Osteoporosis	Osteoporosis	Osteop.	Calcif^{n}	Calcif^{n}	Osteopo.	Calcific^{n}	Calcific^{n}	Calcific^{n}	Inactive	Mod. Calcific^{n}
Urine Ca. %	11.5%	29%	10.14%	9.7%	0.2%	5.8%	9.7%	1.3%	0.7%	0.5%	3 %	0.1%
Blood Ca.	8.8	6.0	14.9	8.8	9.4	8.9	9.6	11.2	8.7	8.9	10.6	8.6
Renal etc. Symptoms	Shadow	Stones & Tb. kidney	-	-	-	-	-	-	-	-	haemat. uria	
Urine Ca. % in Control	14 %	2.42%	5.1%	10.3%	.01%	0.83%	2.5%	0.13%	0.7%	-	12.5%	

Relation to Age and Sex.

On the figures shown, the girls appear to excrete more urinary calcium than the boys. But there are very few examples from which to judge and two of the three have very extensive and active lesions. One of these two was found later to have a tuberculous kidney. This was removed by Mr. Telford, and two stones recovered and examined (see Section II).

The third case, Case A, showed a shadow in the pelvis, for some time during the treatment; this subsequently disappeared. The child, a Jewess, showed a very marked reaction to sunlight, and was found to have a severe microcytic anaemia. Thereafter she was only exposed to the sun for very short periods daily. In her case, it may be that the pelvic shadow was due to excess of vitamin D.

The boys show varied figures, though on the whole the higher urinary calcium numbers tend to collect at the younger end of the group.

Relation of urinary output to length of time bedfast.

These two factors do not appear to bear any correlation to one another. The patient most recently recumbent having been in bed for 1½ years, it is not reasonable to expect anything but equilibrium.

Relation of urinary output to blood calcium.

Here there is no parallel to be drawn, but it is interesting to note that Case B, where there is advanced osteoporosis and active tuberculosis in the kidney, the blood calcium figure is very low. Clinically the patient's appearance was similar to Case 2, Section III.

Relation between urinary output of cases and controls.

No constant relationship could be found here.

Relation between urinary output and extent and stage of disease.

Arranged according to percentage output in urine, the first six cases include all those showing osteoporosis and two out of three with extensive involvement - thus

B.	F.B.	29%	extensive	osteoporotic
A.	G.L.	11.5%	moderate	calcifying
C.	M.R.	10.14%	extensive	osteoporotic
G.	D.M.H.	9.7%	gross	osteoporotic
D.	W.L.	9.7%	gross	osteoporotic

This would appear to mean that the calcium mobilised at site of the disease, is in great part at any rate, excreted by the urine.

Is then, the calcium from a bone, atrophied by disuse, excreted mainly in the urine?

It is interesting to note that G.L., with moderate damage and at the stage of calcification, should be in this group. This child, already mentioned, may have suffered from over-vitaminosis, or was this disposition of calcium due to some disturbance of the colloidal balance?

A study of the comparative X-rays of long bones.

Comparative opasity was estimated according to

1. Circumference of bone.
2. Degree of penetration of X-rays.
3. Breadth of dense bone.
4. Breadth of medullary cavity.

Arranged in order of disparity between Case and Control, the cases range as follows:

Case	Recumbent years	Blood Ca.	Urinary Ca.	Extent of disease	Stage of disease
C M.R.	11	14.9	10.14%	Extensive	Osteoporosis
J F.T.	4	8.9	0.5%	Extensive	Calcifying
B F.B.	6	6.0	29 %	Extensive	Osteoporosis
A G.L.	2½	8.8	11.5%	Moderate	Calcifying
I J.S.	11	8.7	.7%	Gross	Calcifying
L S.M.	10	8.6	.1%	Gross	Mod. calcific.
G D.McH	4	9.6	9.7%	Gross	Osteoporosis
F M.K.	4	8.9	5.8%	Gross	Calcific^{n}.
D. W.L.	3	8.8	9.7%	Gross	Osteoporosis
H H.P.	1½	11.2	1.3%	Moderate	Calcific^{n}.
K M.B.	2	10.6	3 %	Slight	Stationary
E C.H.	6	9.4	0.2%	Gross	Calcific^{n}.

Relation of opacity of bone to period of recumbency.

No. 1 and Nos. 5-11 conform to expectations, the larger the period of rest, the less dense the bone.

Of the exceptions, those which show bony atrophy out of proportion to their period of disuse, two cases, 3 & 4, are cases with signs of renal disturbance, Case B, the girl whose kidney was removed, Case A the child who reacted so violently to sunlight.

Relation of opacity of long bone to blood calcium.

With the exception of one case, all the blood calcium figures fall within or just below the limits of normal adult blood calcium. There is apparently no relationship between the amount of calcium in the blood and that present in the long bones.

Relation of opacity of long bone to extent and stage of disease.

From the preceding table, some degree of positive correlation appears between the extent of the disease and X-ray Shadow of long bones, but the relationship is not absolute.

There does not appear to be any relation between long bone opacity and the stage of the disease.

Relation between opacity of bone and urinary output of calcium.

There is great variation in the calcium output - both as a percentage figure of total excretion and as compared with the corresponding control.

There was no comparison between the urinary output and the period of recumbency, but a definite relationship between recumbency and bony atrophy. It would seem reasonable to expect therefore an absence of correlation between the factors in sub-heading.

GROUP II.

	Daily Ca intake	Daily Ca Output			Daily Ca retention	Daily Ca retent. per kilo	Extent. and stage of disease	Recumbency in years	Blood Ca
		Urine	Fasces	Total					
F Case 1	1.485	9.4% .0270	.2608	.2878	1.1972	.0880	Extensive	1	8.0
Cont.1		13.5% .0256	.1670	.1926	1.2924	.0666	Osteoporotic	-	10.2
Case 2	1.485	8.8% .0298	.3120	.3418	1.1432	.0664	Mod.	6/12	14.0
Cont.2		22.9% .0429	.1422	.1881	1.2999	.0726	Calcifying	-	10.4
Case 3	1.485	12.8% .0459	.3147	.3606	1.1244	.0712	Mod.extent.	1 8/12	11.6
Cont.3		8.0% .0233	.2637	.2870	1.1980	.0573	Mild activity	-	9.5
Case 4	1.485		.1493					1 4/12	
Cont.4		.0253	.2637	.2870	1.1980	.0573		-	9.5
Case 5	1.485	25.4% .0683	.1599	.2282	1.2568	.0700	Extensive	6/12	6.5
Cont.5		16.7% .0344	.1682	.2026	1.2824	.0750	Osteoporotic	-	11.0
Case 6	1.485	28.8% .0382	.0942	.1324	1.3526	.0845	Extensive	3	11.2
Cont.6		7.8% .0162	.1895	.2057	1.2793	.0673	Osteoporotic	-	9.9
Case 7	1.485	4.4% .0223	.4946	.5167	0.9681	.0570	Extensive	3	9.5
Cont.7		56% .0461	.0366	.0826	1.4024	.0738	Osteoporotic	-	10.6
Case 8	1.485	21.1% .0575	.2133	.2708	1.2142	.0660	Moderate	9/12	12.6
Cont.8		7.8% .0162	.1895	.2057	1.2793	.0673	Calcifying	-	9.9
Case 9	1.485	26.5% .0595	.1635	.2230	1.2620	.0618	Mod.	7/12	10.7
Cont.9		7.8% .0162	.1895	.2057	1.2793	.0673	Osteoporotic	-	9.9
Case 10	1.485	23% .0831	.2773	.3604	1.1246	.0592	Extensive	1	14.7
Cont.10		5.6% .0461	.0366	.0826	1.4024	.0738	Osteoporotic	-	10.6

GROUP II.

Arranged as Group I.

CASE	1	2	3	4	5	6	7	8	9	10
Sex	F	F	M	M	M	M	M	M	M	M
Age	$4\frac{10}{13}$ y.	$5\frac{10}{12}$	4	$4\frac{2}{12}$	$4\frac{3}{12}$	$5\frac{10}{12}$	6	$6\frac{1}{12}$	$6\frac{2}{12}$	$7\frac{4}{12}$
Bedfast	1 Yr.	$\frac{6}{12}$ Yr.	$1\frac{8}{12}$ Yr.	$1\frac{4}{12}$ Yr.	$\frac{6}{12}$ Yr	3 Yrs.	3 Yrs.	$\frac{9}{12}$ Yr.	$\frac{7}{12}$ Yr	1 Yr
Extent disease	Extensive	Mod.	Mod.		Extensive	Extensive	Extensive	Mod.	Mod.	Extensive
Stage disease	Osteoporotic	Calcif.	Mild act.		Osteoporotic	Osteoporotic	Osteoporotic	Calcif.	Osteoporotic	Osteoporotic
Urine Ca %	9.4%	8.8%	12.8%	-	25.4%	28.8%	4.3%	21.1%	26.5%	23%
Blood Ca.	8 mg.	14.0	11.6	-	6.5	11.2	9.5	12.6	10.7	14.7
Ca Retent. per kilo	.0880	.0664	.0712	-	.0700	.0845	.0570	.0660	.0618	.0593

Relation of Age and Sex.

As compared with Group I, there is greater excretion of urinary calcium in the younger children comprising Group II. There does not appear to be any particular relationship to sex here.

Relation of Urinary output to length of time bedfast.

		Case	Control.
Recumbent	$\frac{6}{12}$ year	8.8 %	22.9 %
	$\frac{6}{12}$	25.4	16.7
	$\frac{7}{12}$	26.5	7.8
	$\frac{9}{12}$	21.1	7.8
	1 year	23	56
	1	9.4	13.5
	$1\frac{8}{12}$ years	12.8	8.0
	3	4.3	56.0
	3	28.0	7.8

The "control" figures are too variable to be of assistance. Scrutinising the "case" figures, there is much variance in the figures of those recumbent more than 1 year, which corresponds to the findings in Group I. In the cases of more recent recumbency,

there is a more consistent high output of urinary calcium, which bears a more constant relation to the controls.

Relation of Urinary output to Blood Calcium.

There is no correspondence between these two figures thus:

Blood Ca.	Urinary Ca.
9.5 mgms. per 100 cc's.	4.3 %
14.0	8.8
8.0	9.4
11.6	12.8
12.6	21.1
14.7	23.0
6.5	25.4
10.7	26.5
11.2	28.8

The factors of extent and stage of the disease does not enter here, since all the cases are in the early, osteoporotic stage, and nearly all show extensive involvement. There is however a noticeably high blood calcium figure.

Relation of Urinary output of Calcium between cases and controls.

Majority of cases have higher loss by the kidney.

There is very little difference in the relative figures thus:

Relation of Calcium retention between cases and controls.

All cases and controls showed positive retention of calcium. The lowest retention figures were in a recumbent boy, aet 6 years, at rest 3 years = 0.057 g. CaO per Kgm. per day, and an ambulant control, aet 4 years, 0.0573. The highest retention figure was in a recumbent patient, a girl aet 4 10/12, at rest 1 year, 0.0880 g. CaO per Kgm. per day.

Between these the averages were:

Cases	.0693
Control	.0689

Relation of Calcium figures to degree of opacity of bone.

In this group there is very little to choose between the differences of opacity of patient and control.

Arranged thus:

Case No.	% Calc. in Urine.	Retention Ca. per Kg. per day.
6	28.8	.0845
3	12.8	.0712
5	25.4	.0700
1	9.4	.0880
2	8.8	.0664
7	4.3	.0570
8	21.1)	.0660
10	23.0)	.0592
9	26.5)	.0618

Relation to extent and stage of disease.

These cases, unlike Group I, were all in the early stage of the disease, and mostly in the osteoporotic stage, Of the only two which could be said to be calcifying, one was excreting 8.8 % Calcium in urine, and retaining .0664 gm. CaO per Kgm. per diam. The second was excreting 21.1% Calcium in urine, and retaining .0660 gram CaO per Km. per diam.

There was less difference in this group, when classified according to extent of disease.

Case No.	Moderate Retention per Kgm. per diam.	Involvement Output.	Case No.	Extensive Retention.	Involvement Output.
2	.0664	8.8 %	1	.0880	9.4 %
3	.0712	12.8 %	5	.0700	25.4 %
8	.0660	21.1 %	6	.0845	28.8 %
9	.0618	26.5 %	7	.0570	4.3 %
			10	.0592	23.0 %

The high and low figures appear to be well distributed throughout both groups.

GENERAL SUMMARY.

1. Routine examination of urines showed that in the cases of Bone and Joint Tubercle, there was
   (a) A greater number of urines with mineral deposit, and that composed of calcium oxalate and calcium magnes. phosphate.
   (b) A greater number with cellular abnormality.

2. Analysis of three stones recovered from the urinary tract of patients long recumbent from bone and joint disease gave high calcium content of the stones.

3. Examination of serum calcium showed this in general to be very stable.
   (a) There is no relation to general condition of patient, to tuberculin reactivity, sedimentation rate or duration of period in bed, in a few cases chosen.
   (b) Gross bone destruction as shown in X-ray does not appear to affect the serum calcium.
   (c) There is a normal serum calcium with stages of re-ossification.

4. Group I.
   (a) The urinary calcium in this group is very variable. The serum calcium is much more stable.
   (b) The urinary calcium is not related to the period

of immobilisation.

(c) There appears to be a definite relationship to re-calcification e.g., - bone destruction cases show high urinary calcium, re-ossification cases show low urinary calcium.

(d) There appears to be no relationship between loss of calcium by the kidney and degree of opacity of the long bones.

Group II. Acute and more recently recumbent.

(a) In this group the serum calcium is generally above normal.

(b) As in the previous group, osteoporosis is associated with increased urinary calcium output.

(c) Recent recumbency shows a high urinary Ca excretion which is variable when the period of recumbency increases.

(d) As between cases and controls, there is a higher Ca output in the cases, and a lower blood calcium.

(e) There is no definite relationship between urinary calcium and opacity of long bones.

DISCUSSION.

The foregoing has been an attempt to correlate calcium excretion with bony density.

Various theories of stone formation have been postulated. In the cases examined, infection has been excluded. Stasis is surely a secondary factor.
The part played by colloidal balance is interesting - Spitzer and Hilkowitz suggest that the p H variation may be responsible for the precipitation of colloids or crystalloids. Calmette mentions the fact of increased acidity in urines of early tuberculous patients with fall in later cases. In the present examination 99 % of the Section I urines are strongly acid, but this is a constant factor in both recumbent and ambulant cases. It is to be regretted that the exact p H was not determined.
Enzymes have been suggested as playing a part in the formation of stone. The small amount normal in plasma is greatly increased in generalised bone disorders, probably by diffusion from osseous tissues. * (Kay and Robinson).
Two mechanisms are queried.
(1) Phosphatase mechanism which produces in bone matrix fluid a condition of super saturation with respect to bone phosphate.
(2) "Inorganic" mechanism which favours deposition of

this salt from supersaturated solutions.
My colleague (Murray) at Abergele Sanatorium, investigated more than 50 cases of bone and joint tubercle, measuring the blood phosphatase in each. He found his results variable, but concluded that this subject would repay further inquiry.

The remaining causative factors of stone are those already mentioned.

Excessive Vitamin D.
Excessive Calcium.
Deficient vitamin A.
Deficient Phosphorus.

Regulation of vitamins is routine in a sanatorium.
There remains the mineral metabolism.
Section I shows greater urinary deposit in the bone and joint cases. Mr. Telford's three cases of stone are mainly composed of Calcium.
In conclusion the following questions should be answered:
1. In the recumbent patient, is the urinary excretion of calcium increased?
2. If so, is it due to increased intake, or
3. Decreased or negative retention, or
4. Alteration of proportion between faecal and urinary output?

5. Does increased urinary Ca coincide with bony atrophy
   (a) at site of lesion
   (b) in long bones.
6. Does increased urinary Ca coincide with symptoms or signs reverable to the tract.
7. Is bony atrophy greatest where urinary symptom occurs?

1. It has been previously observed that in the cases examined there is a large output of urinary calcium.
2. According to Toverud, the normal calcium requirements of the individual are stated to be 0.9 to 1.0 gm. Ca maximum, and 0.63 gm. minimum per 70 Kgm. body weight. The maximum falls short of the optimum during periods of growth and lactation, and intake of calcium should then be increased to 1.5 gm. per day.
   Stevenson and Cuthbertson allowed amounts of 1.981 and 1.798 for their child patients. An allowance of 1.485 was made for the children in this investigation.
3. Positive retention was shown in every case.
   According to Cuthbertson, in a normally healing fracture, retention varies from 0.0128 g. to 0.0066 g. Ca O per Kgm. per day.
   In pathological fracture, he finds slight retention, and on the whole, very little alteration in the calcium metabolism.
   Hoppe Seyler's cases were excreting 0.7210 gm. to

0.3785 gm. per day, but the actual amount of calcium lost was never completely determined.

Von Noorden found signs of a negative calcium balance.

Ford and Macrae found two normal children aet 2½ years and 5 years, retaining .0429 and .039 g. per day.

On these data, it appears that the children in this inquiry, are giving high retention figures.

4. Of the total excretion, the urinary percentage here is considerably higher than Peters and Van Slykes' figures.

Telfer considered the kidney as the sole or main route for excretion of calcium, but the consensus of opinion favours the large bowel.

5. The increased urinary Ca appears to coincide with osteoporosis at site of disease, but has no clear relationship to long bone atrophy.

There are too few cases to form a definite opinion, but it is interesting to note in Section IV , group I that the two cases with greatest urinary output are those with urinary symptoms, and these cases are Nos. 2 and 3, when graded according to long bone atrophy.

Other points of note are the definite loss of calcium by the urine in the early cases of tubercle (Popovicini, ? Calmette's acidity) and the coincidence of greatest retention where the long bone is most atrophied.

The results are not conclusive, but are suggestive, and further investigation might be pursued with interest.

REFERENCES.

Calmette "Tuberculosis in Man and Animals" 1923.

Cuthbertson, D.P. Bioch. J. vol XXIV No.4, 1244-1263, 1930

Kay Biochem. J. 89, 20, 22.

Murray, W.A. "Estimation of plasma phosphates" 1934.

Peters and Von Slykes. "Interpretation".

Robinson et al. Biochem. J. 17, 24.

Spitzer and Hilkowitz. Journ. Urol. 1924, XI, 10.

Stevenson, G.H. and Cuthbertson D.P.
"Blue Sclerotics and assoc. defects"
Lancet, Oct. 10, 1931 p. 782.

Telfer Quart J. of Med. 16, 45, 1922.

Toverend, K.V. & G. Act Paediat. XII Suppl. 2.

Von Noorden and Belgradt, K.
"Zur Pathologie der Kalkstoff Wechsel"
Berl. Klin. Wohnschr. 31, 235, 1894.

CASE RECORDS.

SECTION I. Case Histories.

Bone and Joint Cases - Spinal Caries.

1. L. Clinton. F. Aet 4 years. Tuberculosis contact. General condition good, local activity. Temperature irregular. Sedimentation graph - diagonal curve, improving. Tuberculin reaction $\frac{1}{1000}$ IV.
Urine: Acid, Sp.gr. 1022. Calcium oxalate crystals, cellular debris.

2. A. Hood. F. Aet 4 years. Tuberculosis contact. General condition poor, local active. Temperature irregular. Sedimentation graph - diagonal curve, improving. Tuberculin reaction $\frac{1}{1000}$ IV.
Urine: Acid, Sp.gr. 1018. Trace albumen.

3. I. Joynt. F. Aet 5 years. No contact. General condition good, local inactive. Temperature stable. Sedimentation graph - diagonal curve, improving. Tuberculin $\frac{1}{1000}$ II. Urine: Acid, Sp.gr. 1024. Calcium oxalate crystals, cellular debris.

4. M. Roberts. F. Aet 12 years. Tuberculosis contact. General condition poor. Local active with sinuses. Temperature irregular. Sedimentation - horizontal curve, increasing. Tuberculin $\frac{1}{1000}$ I.
Urine: Pale, clear, acid, Sp.gr. 1024. Epithelial

debris, oxalate crystals. Albuminuria, bacilluria.

5. W. Newton. F. Aet 7. No contact. General condition poor, local active, with sinuses. Temperature irregular. Sedimentation graph: vertical curve. Tuberculin $\frac{1}{1000}$ I.
Urine amber, cloudy, acid, Sp. gr. 1012. Faint trace albumin.

6. E. Coles. F. Aet 11. No contact, general condition poor, local active. Temperature irregular. Sedimentation graph, horizontal curve. Tuberculin $\frac{1}{1000}$ IV. Urine: Amber, acid, 1024, faint trace albumen, cellular debris, phosphatic needles.

7. E. Gillan. F. Aet 14 years. Tuberculosis contact, general condition good, local condition active. Sedimentation, horizontal curve, improving. Tuberculin $\frac{1}{1000}$ IV. Urine: clear, amber, Sp.gr.1024, acid, faint trace albumen.

8. J. Connolly. F. Aet 13 years. Tuberculosis contact, general condition good, local active. Temperature stable. Sedimentation graph. vertical curve improving. Tuberculin $\frac{1}{1000}$ III. Urine pale, acid, Sp.gr. 1014, epithelial debris ++

9. M. Daulby. F. Aet 13 years. No contact.
General condition fair, local quiescent.
Temperature irregular. Sedimentation graph -
horizontal curve, improving. Tuberculin $\frac{1}{1000}$ IV
Urine pale, acid, Sp.gr. 1024, epithelial debris,
oxalates ++

10. F. Smith. M. Aet 4 years. Tuberculosis contact.
General condition good, local inactive. Temperature
stable. Sedimentation graph: horizontal curve,
improving. Tuberculin $\frac{1}{1000}$ IV. Urine acid, Sp.gr.
1020.

11. W. Davidson. M. Aet 5 years. Tuberculosis contact.
General condition poor, local very active. Temperature
irregular. Sedimentation: vertical curve.
Tuberculin $\frac{1}{100}$ IV.
Urine: Acid, Sp.gr. 1016. Albumen, cellular deposit,
debris.

12. A. Jones. M. Aet 8 years. No contact. General
condition, good, local active. Temperature stable.
Sedimentation: diagonal curve, increasing.
Tuberculin $\frac{1}{1000}$ I.
Urine: pale, faintly acid, Sp.gr. 1012, mucous, earthy
phosphates, coliform bacilluria.

13. D. Johnson. M. Aet 6 years. No contact. General condition fair, local active. Temperature unstable. Sedimentation: Diagonal line, improving. Tuberculin $\frac{1}{1000}$ IV.
Urine alkaline 1020. Albumen, bacilluria, feathery phosphates. History of albuminuria.

14. C. Harrop. M. Aet 6 years. Tuberculosis contact. General condition, fair, local active. Temperature stable. Sedimentation graph, variable. Tuberculin $\frac{1}{1000}$ H. I. Urine: faint acid, 1012, amorphous deposit with feathery crystals.

15. K. Tetlow. M. Aet 5 years. No contact. General condition good, local active. Temperature stable. Sedimentation graph: diagonal curve, improving. Tuberculin $\frac{1}{1000}$ I.
Urine: Acid. Sp.gr. 1022.

16. R. Bateman. M. Aet 5 years. No contact. General condition poor, local active. Temperature high. Sedimentation graph: vertical curve. Tuberculin $\frac{1}{1000}$ IV. Urine acid. Sp.gr. 1018, albumen.

17. E. Archer. M. Aet 12 years. No contact. General condition fair, local inactive. Temperature stable. Sedimentation graph: vertical curve. Tuberculin

$\frac{1}{1000}$ III. Urine: Straw, acid, Sp.Gr. 1028, Calcium oxalate , cells and cellular debris. History of haematuria and pyuria.

18. N. Voellner. M. Aet 11 years. No contact. General condition poor, local active. Temperature irregular. Sedimentation graph: horizontal curve. Tuberculin $\frac{1}{100}$ I. Urine, pale, acid, Sp.gr. 1026, faint trace albumen, cells, debris, oxalates ++

Hip Joint Disease.

19. G. Levy. F. Aet 4, no contact, general condition poor, local active. Sedimentation graph: horizontal line. Tuberculin $\frac{1}{1000}$ I.
Urine: Acid, Sp.gr. 1018, oxalates ++
Small shadow ? pelvis right kidney.

20. M. Callaghan. F. Aet 5. No contact. General condition poor, local very active. Temperature irregular. Sedimentation graph, vertical curve. Tuberculin $\frac{1}{100}$ II. Urine: acid, Sp.gr. 1020. Albumen, phosphates.

21. L. Skelton. F. Aet 8 years. No contact. General condition fair, local active with sinuses. Temperature stable. Sedimentation graph: diagonal curve. Tuberculin $\frac{1}{1000}$ II. Urine: neutral, Sp.gr. 1016, earthy phosphates, B. coli.

22. M. Kaminsky. F. Aet 11 years. No contact. General condition flabby, local inactive. Temperature, stable. Sedimentation graph: diagonal line. Tuberculin $\frac{1}{100}$ I. Urine acid, sp.gr. 1028, cloudy, few needles, debris, casts, albumen.

23. E. Scowcroft. F. Aet 13 years, contact. General condition fair, local active with sinuses. Temperature

irregular. Sedimentation graph: diagonal line. Tuberculin $\frac{1}{1000}$ IV. Urine acid, Sp.gr. 1018, oxalates ++ .

24. W. Leyland. M. Aet 6 years. Contact. General condition poor, local active. Temperature irregular. Sedimentation graph, vertical curve. Tuberculin $\frac{1}{1000}$ II. Urine acid. Sp. gr. 1010.

25. E. Bostock. M. Aet 10 years. No contact. General condition, fairly good, local active, with sinuses. Temperature stable. Sedimentation graph: diagonal line. Tuberculin $\frac{1}{1000}$ II. Urine clear, acid. Sp.gr. 1008, phosphates.
? Old history of ureteric shadow.

26. H. Cooper. M. Aet 12 years. No contact. General condition fairly good, local active. Temperature stable. Sedimentation graph: diagonal line. Tuberculin $\frac{1}{1000}$ IV. Urine: alkaline, pale, Sp.gr. 1018. Mucus, phosphates, faint trace albumen, cellular debris.

27. C. Butler. M. Aet 13 years. No contact. General condition poor, local active, with sinuses. Sedimentation: vertical curve. Tuberculin $\frac{1}{1000}$ I Urine: amber, acid, Sp.gr. 1010, albumen ++

History of nephritis.

28. M. Birtles. M. Aet 13 years. No contact.

General condition good, local inactive.

Temperature stable. Sedimentation graph: Horizontal line. Tuberculin: negative.

Urine: Acid, Sp.gr. 1022. Oxalates ++

History of pyuria, albuminuria.

Knee Joint Disease.

29. E. Norris. F. Aet 7. Contact. General condition poor, local active. Temperature irregular. Sedimentation graph: diagonal line. Tuberculin $\frac{1}{1000}$ I. Urine: Acid, Sp.gr. 1018, oxalates bacilluria.

30. M. McDermott. F. Aet 12. General condition, good. Local inactive. Temperature stable. Sedimentation graph: horizontal line. Tuberculin $\frac{1}{1000}$ I. Urine: Sp.gr. 1032, acid, clear.

31. E. Hoyle. F. Aet. 13 years. No contact. General condition, good, local active. Temperature stable. Sedimentation graph: diagonal curve. Tuberculin $\frac{1}{1000}$ I. Urine, amber, acid, Sp.gr. 1028, cayenne pepper deposit.

32. J. Houghton. M. Aet 7, general condition good, local active. Temperature irregular. Sedimentation graph: horizontal line. Tuberculin $\frac{1}{1000}$ I. Urine: faint acid. Sp. gr. 1010. Very faint trace albumin, phosphates.

33. E. Fowler. M. Aet. 7. General condition good, local active. Temperature stable. Sedimentation graph:

horizontal line.

Tuberculin $\frac{1}{1000}$ III.

Urine acid. Sp.gr. 1022. Debris +

Ankle Joint Disease.

34. F. Hughes. M. Aet 11. General condition, fairly good, local active. Temperature stable. Sedimentation graph: horizontal line. Tuberculin $\frac{1}{1000}$ I. Urine: Sp.gr. 1017, acid, debris, oxalates.

35. S. M. M. Aet 12. General condition fair, local inactive. Sedimentation graph: diagonal curve. Tuberculin $\frac{1}{1000}$ IV.
Urine: acid, sp.gr. 1012, cells, debris, phosphate.

Pulmonary Disease - Hilar.

36. E. Murphy. F. Aet 6 years, general condition poor. Sedimentation graph: horizontal curve, tuberculin $\frac{1}{10,000}$ IV. Urine: acid, sp.gr. 1014, debris.

37. G. Meade. F, aet 14 years. General condition poor. Sedimentation graph: diagonal curve.
Tuberculin $\frac{1}{10,000}$ II
Urine acid, Sp.gr. 1014, oxalates, epithelial cells.

Pulm. Disease - adult.

38. M. Moran. F. Aet 7 years. General condition, fairly good. Sedimentation graph, diagonal line. Tuberculin $\frac{1}{1,000}$ I.
Urine: neutral, sp.gr. 1015, leucocytes, epithelial cells.

39. F. Farish. F. Aet 6 years. General condition, good. Temperature stable. Sedimentation graph: diagonal curve, tuberculin $\frac{1}{1000}$ IV.
Urine: Acid, Sp.gr. 1018, oxalates.

40. I. Daniels. F. Aet 9 years, general condition fair, temperature irregular. Sedimentation graph: vertical curve. Tuberculin $\frac{1}{1000}$ I.
Urine: acid, sp.gr. 1010, phosphates, epithelial cells.

41. F. Ricardo. F. Aet 10 years. General condition good. Temperature irregular. Sedimentation graph: diagonal curve. Tuberculin $\frac{1}{1000}$ I.
Urine: neutral, sp.gr. 1012. Phosphates, epithelial debris.

42. E. Kenyon. F. Aet 12 years. General condition, good. Tuberculin: not done. Sedimentation graph: vertical curve. Urine: acid, 1018, phosphates.

43. J. Lea. F. Aet 12 years. General condition good.
Sedimentation graph: diagonal curve.
Tuberculin: $\frac{1}{10,000}$ II.
Urine: acid, sp.gr. 1014, leucocytes, renal epithelium.

44. A. Booth. F. Aet 13 years. General condition good. Sedimentation graph, diagonal line. Tuberculin $\frac{1}{1000}$ II. Urine: acid, sp.gr. 1020. Cells.

45. I. Dodds. F. Aet 13, general condition good, temperature stable. Sedimentation graph - diagonal line. Tuberdulin not done.
Urine: acid, sp.gr. 1008, debris, cells.

46. M. Gill. F. Aet 14, general condition, poor. Temperature irregular. Sedimentation graph - vertical curve. Urine: 1018, acid, leucocytes, phosphates.

47. M. Larkin, F. Aet 15 years. General condition poor. Sedimentation graph: diagonal line. Urine acid, 1020, cells.

48. E. Bryant. M. Aet 5 years. General condition, good. Sedimentation graph: horizontal line.
Tuberculin $\frac{1}{10}$ IV.
Urine: Sp. gr. 1014.

49. A. Massey. M. Aet 8, general condition good.

Sedimentation graph: vertical line.

Tuberculin: $\frac{1}{100}$ III.

Urine: Sp.gr. 1018.

Renal disease.

50. F. Boden. F. aet 11 years. General condition good.

Sedimentation graph, vertical line.

Tuberculin $\frac{1}{1000}$ II

Urine acid, sp.gr. 1024, albumen, casts.

51. T. Wylde. M. Aet 13 years. General condition poor.

Sedimentation graph: vertical line.

Tuberculin $\frac{1}{1000}$ II.

Urine acid, 1002, albumen, epithelial cells, tubero. bacilluria.

Intestinal Disease.

52. G. Turner. F, aet 10 years. General condition poor. Temperature irregular. Sedimentation graph: diagonal curve. Tuberculin $\frac{1}{1000}$ I.
Urine: acid. Sp.gr. 1000, phosphates, debris, casts albumen.

53. M. Coleman. F, aet 11 years. General condition good. Sedimentation graph: horizontal curve.
Tuberculin $\frac{1}{1,000}$ II.
Urine acid, sp.gr. 1018.

54. G. Machin. F, aet 12 years, general condition good. Temperature stable. Sedimentation graph: diagonal line, tuberculin $\frac{1}{10}$ negative.
Urine: acid, 1022, squamous cells, phosphates, albumen.

55. M. White. F, aet 12. General condition, fair. Sedimentation graph: horizontal line.
Tuberculin $\frac{1}{1000}$ IV.
Urine: Acid, sp.gr. 1014.

56. R. Rogers. M, aet 6. General condition good. Sedimentation graph: horizontal curve.
Tuberculin $\frac{1}{1000}$ III.
Urine: acid. Sp.gr. 1012.

57. W. Qualters. M, aet 9. General condition fair.
Sedimentation graph, diagonal curve.
Tuberculin $\frac{1}{1000}$ IV.
Urine acid, sp.gr. 1018. Oxalates.

58. E. Melia. M, aet 13 years. General condition good.
Sedimentation graph, diagonal curve.
Tuberculin, $\frac{1}{10,000}$ IV
Urine acid, sp.gr. 1012, earthy phosphates, B. coli.

Skin Disease.

59. J. Tippey. M. Aet 5, general condition good.
Sedimentation graph: horizontal curve.
Tuberculin $\frac{1}{10,000}$ I
Urine: acid, sp.gr. 1024, oxalates.

Glandular Disease.

60. L. Spreadborough. F, aet 6 years. General condition, fairly good. Temperature stable. Sedimentation graph: vertical curve. Tuberculin $\frac{1}{100}$ H.
Urine: acid, 1020, clear.

61. J. Davies. F, aet 10 years. General condition good.
Sedimentation graph: horizontal line. Tuberculin $\frac{1}{1000}$ I. Urine: acid 1008, squamous cells, phosphates.

CASE I.A.

CASE I.B.

CASE I.C.

SECTION 3.

CASE 1. S.H. Bedfast 3½ years.

Age: 5 years.

Past history: nil of note.
Family history: nil of note.

History of complaint: Onset gradual.

1931 December:

Dragging of right leg noticed; starting pains during night. Child seen by Mr. Platt - hip put in plaster.
X-ray: "Gross destruction of right hip joint. Joint dislocated and head of femur largely destroyed, its centre being opposite the upper margin of the acetabulum. No evidence of abscess formation, but peritoneum raised from lateral surface of femur to about the middle of shaft".
Large abscess present - with sinus formation.

Fixation - Pyrford frame.

1934 February: Spica.

Little evidence of ankylosis, temperature unstable.

General condition: Good.

Tuberculin reaction: $\frac{1}{1000}$ Human pos. - I

Sedimentation: Horizont.
Straight line.

Blood count:

Red cells	3,240,000
White cells	9,000
Polymorphs	52
Eosinophil	1
Large lymph.	30
Mast	0.5
Large hyaline	0.5
Haemoglobin	64.

CONTROL 1. Control J.L. Ambulant.

Age: 6 years.

Past history: Measles, Chickenpox, Gastro-enteritis (in B.H.I.)

Family history: Mother notified case of pulmonary phthisis.

History of condition: 1930 October. Slight swelling noticed in neck glands. Treated by inunction till

1932 May:

Operation performed and glands scraped.

October:

Case re-notified "Cervical and submaxillary adenitis".

December:

Admitted to Abergele Sanatorium.

X-ray chest: "Right hilum ill-defined; prominent calcareous nodules in lower part of hilum".

General improvement: Slow.

General condition: Good.

Tuberculin reaction: $\frac{1}{1000}$ Human pos. II

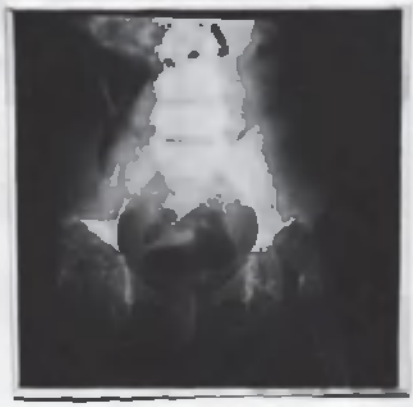
Sedimentation rate: Low, diagonal curve.

Urine examination: Sp. Gr. 1026, Acid, feathery phosphate crystals.

CASE 2. A.

CASE 2. B.

CASE 2. C.



CASE 2. D.

CASE 2. M.C. Bedfast 4 years.
(no control).

Age: 7 years.

Past history: Chickenpox, bronchitis, pneumonia.

Family history: Contact.

History of complaint: 1931, fell downstairs - seen at M.R.I.
X-rayed at Gartside Street.
Admitted to B.H. Infirmary with leg in plaster.

1932 September:

Admitted to Abergele Sanatorium.
X-ray: "Bilateral disease of hip joints, both hips subluxed most marked on right. Left femoral epiphysis partly eroded. Acetebular area well formed and clear. Bone detail good."

1935 April:

"Gross destruction each hip joint with subluxation. Marked bony absorption, numerous calcifying abscesses.

Fixation - Pyrford frame.

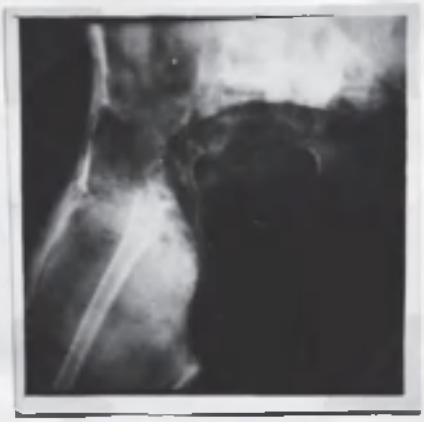
General condition: Poor, numerous sinuses discharging.

Tuberculin reaction: $\frac{1}{1000}$ Human - II

Sedimentation: Vertical curve - v. strep.

Blood count:

Red cells	3,310,000
White cells	8,400
Polymorphs	59
Eosinophils	5.4
Large lymphocytes	10.8
Small "	18.4
Mast cells	1
Large hyaline	3.2
Haemoglobin	60.



CASE 3. A.

CASE 3. B.

CASE 3. C.

CASE 3. D.

CASE 3. M.H. Bedfast 4 years.

Age: 8 years.

Past history: nil of note.
Family history: contact.

History of complaint: Acute onset.

1929 August:

Fell downstairs, child cried a lot and was unable to walk. X-rayed at Ancoats Hospital - several plasters applied.

1930 December:

Admitted to Swinton House. Note - "very acute hip and probably due to direct infection from father".

1931 December:

X-ray Abergele Sanatorium: "Complete destruction of head of right femur and rarefaction of neck and lesser trochanter. Dislocation on to dorsum."

Fixation: 1932, April - Pyrford frame.

1933, April - Plaster spica.

1933, September - freedom in bed.

Ankylosis progressing satisfactorily.

General condition: Good.

Tuberculin reaction: $\frac{1}{1000}$ Human - I

Sedimentation: Horizontal line.

Blood count:

Red cells	4,830,000
White cells	6,600
Polymorphs	63
Eosinophils	2
Large lymph.	9
Small lymph.	24
Mast	1
Large hyaline	1
Haemoglobin	80

CASE 4. A.

CASE 4. B.

CASE 4. C.

CONTROL 3. I.C.

Age: 8 years.

Past history: Scarlet fever.

Family history: Contact.

History of complaint: In 1932 was notified to be pale and languid - very fretful.
Cervical glands swollen.
Seen by senior Tuberculosis Officer.
Admitted to Abergele Sanatorium 24.6.33.
General progress good.

General condition: Good.

Tuberculin reaction: $\frac{1}{1000}$ Human - $\underline{\underline{I}}$

Sedimentation: Vertical curve.

CASE 4. W.N. Bedfast 5 years.

Age: 9 years.

Past history: Bronchitis, inflammation of kidneys.

Family history: Nil of note.

History of complaint:

1929 Seen to limp and screamed when walking.
Admitted to Booth Hall Infirmary, May 1930.

1930 November:

Transferred to Ancoats Hospital O.P.
Put on frame.

1931 October:

Swelling noticed right thigh - sinus formed.
X-ray: 5th L. slightly tilted and flattened and upper two segments of sacrum obscured by shadow of calcifying abscess. Left upper quadrant of sacrum rarefied. Both hip joints normal.

Fixation - Plaster shell.

Small calcareous nodules present under skin of right thigh at point of sinuses.

General condition: Poor.

Tuberculin reaction: $\frac{1}{1000}$ I with ulceration.

Sedimentation: Vertical curve.

CASE 5. L.S. Bedfast 4 years.

Age: 10 years.

Past history: None obtainable.
Family history: None obtainable.

History of condition: Onset about August 1930 - child in Booth Hall Hospital.
X-ray: "Marked rarefaction and haziness of outline of epiphyseal head of femur".

Admitted to Pen-y-Coed November 1930.

1931 August:

X-ray: "Acute disease left hip joint. Head and neck of femur retain shape but are extensively destroyed. Early affection of acetabulum".
X-ray knee joint "Joint space increased. Outer half of femoral epiphysis shows irregularity suggestive of tuberculosis".
Lungs: "Root shadows increased and spreading, especially toward right apex, where there is evidence of parenchymal disease. Faint shadowing of disease through left lung."

Fixation of hip.

1932 - Plaster spica.

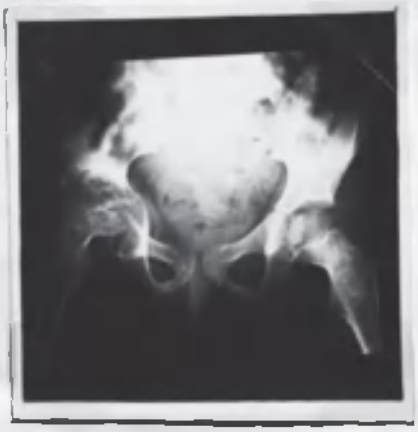
1933 - Pyrford frame - April aspiration of abscess.

1934 - Plaster spica.

General condition: On admission poor, with swinging temperature. Progress good.

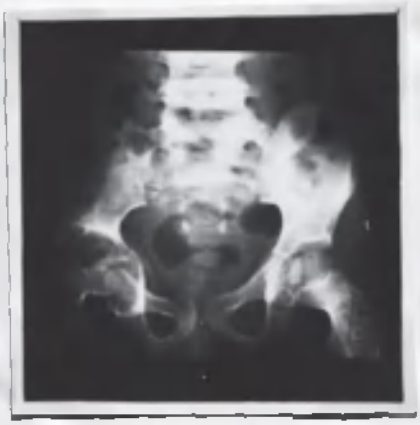
Tuberculin reaction: $\frac{1}{1000}$ Human pos. I

Sedimentation: Vertical curve.

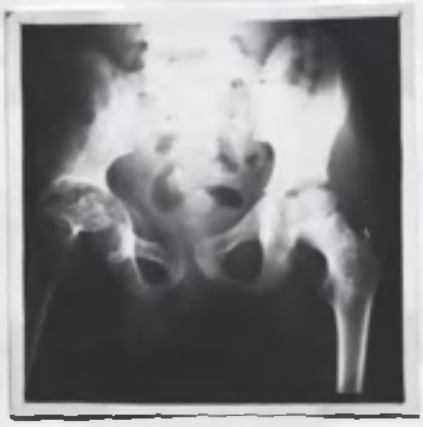


CASE 6. A.

CASE 6. B.



CASE 6. C.



CASE 6. D.

CASE 6. E.

CASE 6. W.L. Bedfast 3 years.

Age: 7 years.

Past history: Measles.

Family history: Contact.

History of complaint: 1931, May: Child sustained an injury while at play, after which he was noticed to limp.
At Ancoats Hospital he was put in plaster.

1931 October:

Admitted to Abergele Sanatorium.

X-ray chest: "Root glandular enlargement and fibrosis".
At hip joint: "General osteoporosis of epiphysis and neck of right femur".

1932 August:

X-ray: "Bony architecture improved."

Fixation 1932 August. Frame.

1932 December. Berck tray.

General condition: Poor.

Tuberculin reaction: $\frac{1}{1000}$ Human pos. I

Sedimentation: Vertical curve.

Blood count:

Red cells	3,840,000
White cells	5,200
Polymorphs	45
Eosinophils	3
Large lymph.	14
Small lymph.	3.3
Mast	0.9
Large hyalin	5
Haemoglobin	70

CONTROL 6. J.S. Ambulant.

Age: 7 years.

Past history: Good.

Family history: Contact.

History of Complaint:

1931 September:

Pustule noticed on right cheek.

1931 December:

Operation Skin Hospital.

1932 November:

Gradual increase in size of cervical glands.

1933 May:

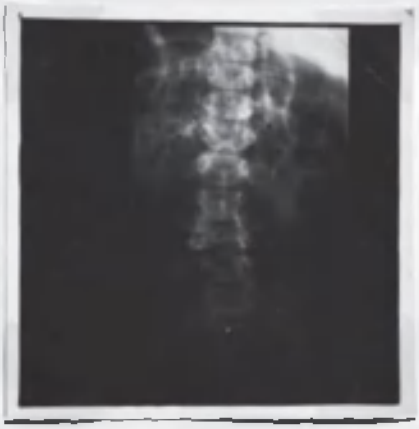
Admitted to Abergele Sanatorium.

X-ray chest: "Congestion right hilum".

General condition: Poor.

Tuberculin reaction: $\frac{1}{10,000}$ Human T

Sedimentation test: Diagonal line.



CASE 7. A.

CASE 7. B.

CASE 7. C.

CASE. 7. D.

CASE 7. W.D. Bedfast 3½ years.

Age: 7 years.

Past history: None of note.
Family history: Contact, father and sister.

History of complaint:

1931 October:

Child noticed to limp, leg seemed short. Seen by Mr. Platt. X-rayed, put in plaster spica.

1932 February:

Admitted to Abergele Sanatorium in plaster.

March:

X-ray: "Disease of right hip joint mainly localised in inner aspect of epiphysis of head, but with extension of disease into the head and irregularity of articular surface on medial portion of head."

September:

X-ray: "Definite and advanced disease of 3rd and 4th L.V., the bodies of which appear to have collapsed together. The shadow of a right psoas abscess can be made out.

Fixation: Plaster spica.

1933 April - Plaster shell.

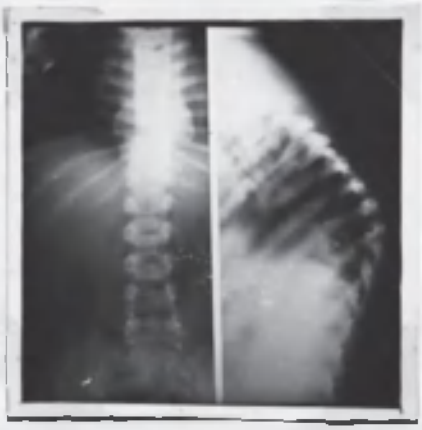
September - Berck tray.

October - Pyrford frame.

General condition: Poor.

Tuberculin reaction: $\frac{1}{100}$ Human IV

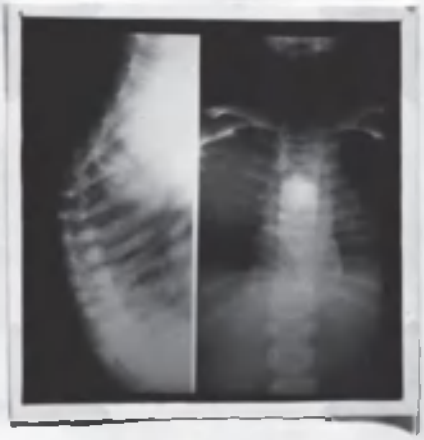
Sedimentation: Diagonal curve, steep.



CASE 8. A.

CASE 8. B.

CASE 8. C.



CASE 8. D.

CASE 8. C.H. Bedfast 6 years.

Age: 7 years.

Past history: Diphtheria, measles, otorrhoea.

Family history: Tuberculosis contact.

History of complaint: Onset gradual till March 1929, when a lump was noticed on child's back.

Progress: X-ray "Extensive disease of 9. 10. 11. D. No abscess formation."

1932 February:

Small saccular abscess.

1934 January:

Destruction progressing.

1934 April:

? Increase in abscess and osteoporosis.

Fixation:	1931 September:	Plaster jacket.
	1932 February:	Pyrford frame.
	1932 August:	Celluloid jacket. Ambulant for six weeks.
	1933 April:	Plaster jacket with fillet.
	1934 November:	Mr. Telford. Hibb's operation - fixation in anterior shell.

General condition: Fair.

Tuberculin reaction: $\frac{1}{1000}$ Human positive I

Sedimentation: Diagonal curve - steep.

Blood Count: No abnormality.

CONTROL 8. R.H. Ambulant.

Age: 7 years.

Past history: Good.

Family history: Good.

History of complaint: January 1931 parents noticed gradual loss of energy and flesh.

1931 March:

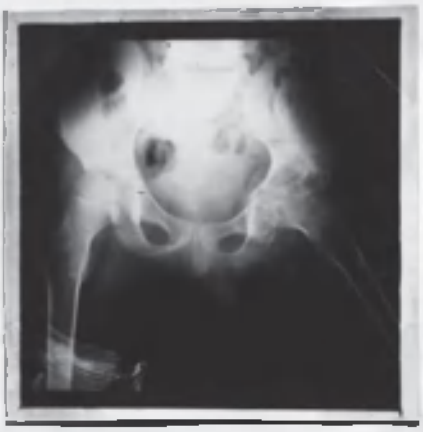
Child complained of abdominal pain and suffered from vomiting and frequency of micturition.

He was seen at the Tuberculosis Offices, and sent to Abergele Sanatorium 30.8.32.

General condition: Fair.

Tuberculin reaction $\frac{1}{1000}$ II

Sedimentation: Horizontal line.



CASE 9. A.

CASE 9. B.

CASE 9. C.

CASE 9. M.K. Bedfast 4 years.

Age: 8 years.

Past history:

History of complaint: Child fell off table in October 1929. He developed a slight limp and was seen at Ancoats Hospital, X-rayed and put on frame in July 1930.

In November 1931 he was admitted to Abergele Sanatorium.

X-ray: "Disease right hip joint. Head of femur osteoporotic and flattened."

Thereafter he was treated on Pyrford frame and then plaster. X-rays showed calcifying abscess and no increase in osteoporosis. General progress was average and steady.

General condition: Fairly good.

Tuberculin reaction: H $\frac{1}{1,000}$ IV

Sedimentation test: Diagonal line.

Urine examination: Sp. gr. 1018, acid, amorphous and knife rest deposit.

CONTROL 9. R.R. Ambulant.

Age: 8 years.

Past history: Measles, bronchitis, pneumonia, chickenpox.

Family history:

History of complaint:

Onset was gradual. Child did not thrive from age of 5 months. In 1927 there was some doubt as to possible spinal disease, due to prominence of first lumbar spine - in 1929, child developed enlarged cervical glands, was taken to Booth Hall Infirmary and then seen at Gartside Street in 1930, where it was found that he had also some fluid on right side of chest.

February 1932, Tuberculosis Officer found distension of abdomen and admitted child to Abergele Sanatorium.

Progress was very slow, but there has been a gradual amelioration.

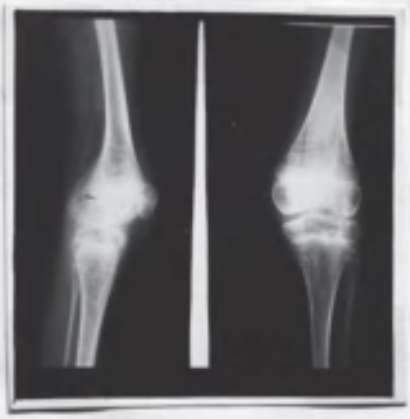
General condition: Fairly good.

Tuberculin reaction:

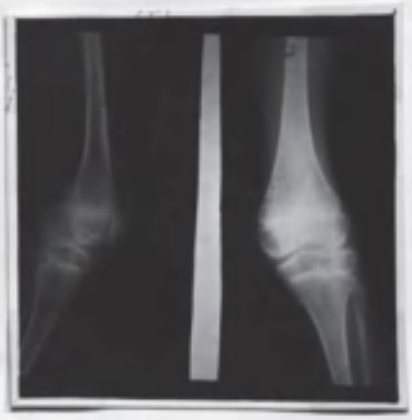
Sedimentation test:

Urine examination: Sp. Gr. 1025 ft a tr. albumen, gran. casts bacilli.

CASE 10. A.



CASE 10. B.



CASE 10. C.

CASE 10. E.F. Bedfast 4½ years.

Age: 9 years.

Past history: Scarlet fever.

Family history: Nil of note.

History of complaint:

1929 December - Fell off chair. Injury right knee. Immobilised - Thomas' splint and in plaster case.

X-ray: "Joint space increased - rarefaction of outer half of lower femoral epiphysis. Rarefaction of patella.

Fixation in plaster spica.

1932 September: Pyrford frame.
October: Spica frame.
1933 April: Short plaster case.

General condition: Fairly good.

Tuberculin reaction $\frac{1}{1000}$ Human, pos. I

Sedimentation: Diagonal curve, steep.

Blood count: No abnormality.

CONTROL 10. J.O. Ambulant.

Age: 9 years.

Past history: Measles, whooping cough, German measles.

Family history: Contact.

History of condition:

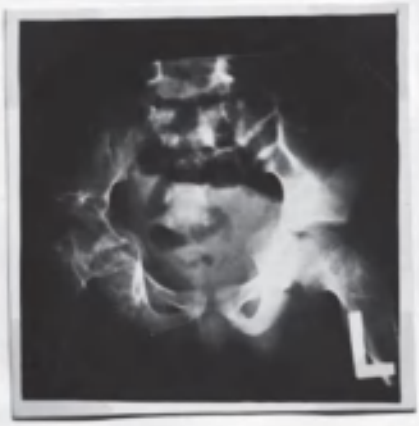
1932 August: Complaint of headaches.
October: Loss of weight, complaint of pain in abdomen and left thigh.
Bowels regular.

1933 February: Seen at St. Mary's Hospital by Dr. Ward.
Chest X-rayed: "Pulmonary phthisis".
September: Admitted to Abergele Sanatorium.
X-ray: "Calcareous nodules right hilum - no other abnormality.

General condition: Fairly good.

Tuberculin reaction: $\frac{1}{100}$ Human / Bovine pos. $\overline{\underline{IV}}$

Sedimentation: Horizontal line.



CASE II. A.

CASE II. B.

CASE 11. D.McH. Bedfast 4 years.

Age 9 years.

Past history:

Family history:

History of complaint:

June 1930, child fell and bruised right side. Following this he was fretful, had pain on moving leg and walked with a limp.

June 1930. X-rayed Ancoats Hospital. Hip put in plaster.

1931 February:

Removed to Swinton House. Plaster again applied.
X-ray: "Head and neck of femur osteoporotic joint space much narrowed, acetabulum rarefied."

1932 January:

Transferred to Abergele Sanatorium. Progress poor. Abscess developed, sinus formation followed several aspirations.

August:

Pathological fracture of femur.

1933 October:

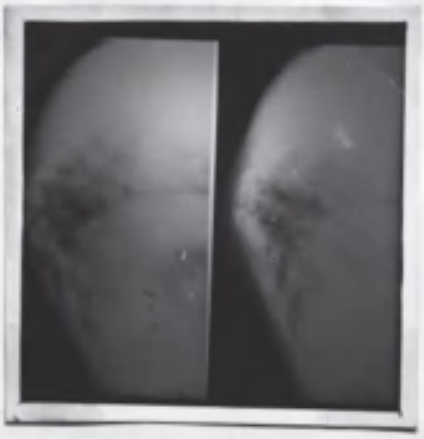
Pyrford frame fixation.

General condition: Poor.

Tuberculin reaction: $\frac{1}{1000}$ Bovine pos. III

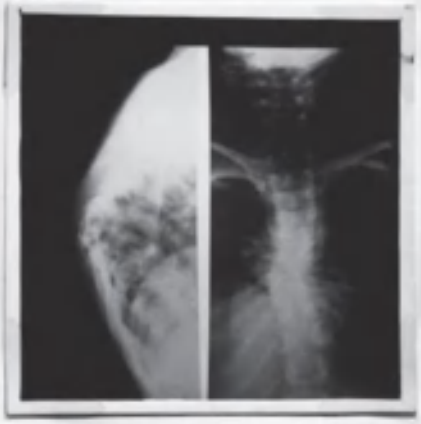
Sedimentation: Diagonal curve, steep.

Blood count: No abnormality.



CASE 12. A.

CASE 12. B.



CASE 12. C.

CASE 12. N.V. Bedfast 4 years.

Age: 13 years.

Past history: Measles, chickenpox.

Family history:

History of complaint:

1924 - child noticed to stoop when walking, then lump seen on back.
Seen at Ancoats Hospital - put in plaster splint.

1930 - admitted to Swinton House - in hyper-extension.

1931 - plaster jacket.

1932 - Admitted to Abergele Sanatorium.

X-ray: "Destructive disease 4th to 9th D.V. Very little evidence of bony reformation."

General condition: Poor.

Tuberculin reaction: $\frac{1}{100}$ Human pos. with ulcer I

Sedimentation: Diagonal line, shallow.

Blood count: No abnormality.

October.

abnormalis

CASE 13. A.

CASE 13. B.

CASE 13. C.

CASE 13. J.S. Bedfast 11 years.

Age: 13 years.

Past history: nil of note.
Family history: nil of note.

History of complaint: Onset gradual in 1923, limp noticed. Boy admitted to Booth Hall Infirmary.

1931 June: Admitted to Abergele Sanatorium.

X-ray: "Extensive disease of acetabulum and ilium".
Abscess and sinus formation.

1933 February: Sinuses scraped.

X-ray: "Considerable formation of new bone."

1934 June: X-ray: "Increased sclerosis in ilium - ankylosis not quite sound."

Fixation 1931 October. Listen with extension.

1932 January. Double spica.

General condition: Fair.

Tuberculin reaction: $\frac{1}{20}$ Human. Pos. IV

Sedimentation: Diagonal curve, steep.

Urine examination: Sp. gr. 1022, acid.
Feathery phosphate and oxalates.

Blood count: No abnormality.

CONTROL 13. C.S. Ambulent.

Age: 12½ years.

Past history:

Family history:

History of complaint: Onset gradual during 1927. Occasional abdominal pain and vomiting.

1930 April. Had ultra violet ray treatment at Gartside Street.

December. Notified Tabes Mesenterica.

1933 April. Admitted to Abergele Sanatorium.

X-ray: "Shadows right hilum".

Improvement very slow.

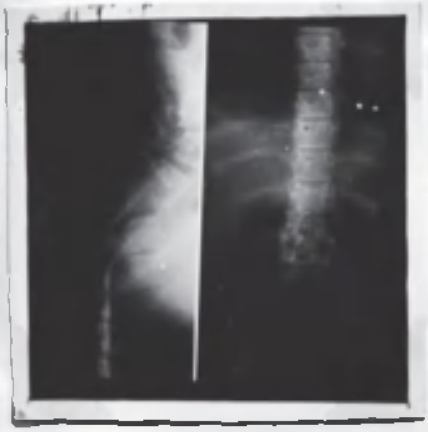
General condition: Fair.

Tuberculin reaction: $\frac{1}{1000}$ Bovine pos. III

Sedimentation: Sp. gr. 1012, acid. Trace of epithelial debris.

CASE 14. A.

CASE 14. B.



CASE 14. C.

CASE 14. D.

CASE 14. F.T. Bedfast 4 years.

Age: 13 years.

Past history:

Family history:

History of complaint: Onset very gradual, child thin and languid until November 1930 when lump was noticed in back. Boy seen at Manchester Royal Infirmary - put on frame. X-ray: "2nd L.V. destroyed. 3rd L.V. extensively eroded".

1931 June: Admitted to Abergele Sanatorium.

Fixation September. Berck tray with hyperextension.

1932 August: Lumbar plaster.

1934 X-ray: "Evidence of recalcification. Still some osteoporosis."

General condition: Fair.

Tuberculin reaction: $\frac{1}{100}$ Human. pos. II

Sedimentation: Vertical curve.

Blood count. No abnormality.

CONTROL 14. J.H. Ambulant.

Age: 13 years.

Past history:

Family history: Mother has phthisis pulmonalis.

History of complaint: Onset acute in November 1928. Patient had feverish cold with very high temperature.

Two weeks later, cough developed, child was admitted to Booth Hall Infirmary, where he was reported to have a "Collapse left lung, slowly diminishing".

Since then, condition slowly improved.

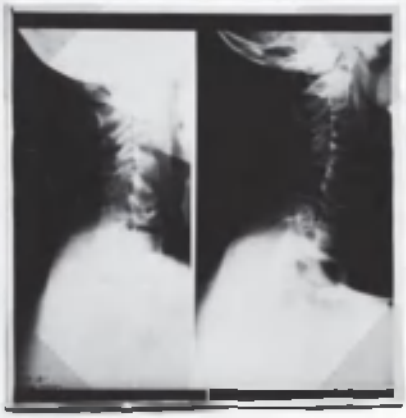
X-ray chest: "Nil in parenchyma. Scattered glandular nodules in chest."

General condition: Fairly good.

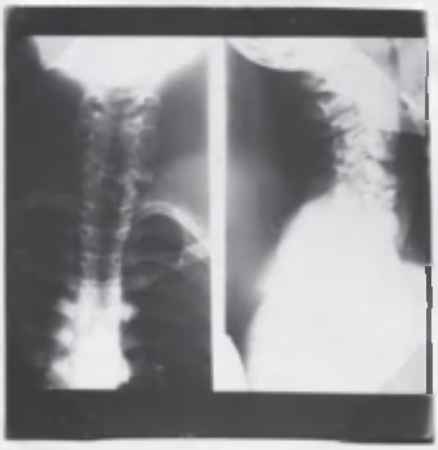
Tuberculin reaction: $\frac{1}{10,000}$ Human pos. III

Sedimentation: Horizontal line.

CASE, 15. A.



CASE. 15. B.



CASE. 15. C.

CASE 15. E.A. Bedfast 2 years.

Age: 14 years.

Past history: Influenza, Scarlet fever.

Family history:

History of condition:

About 1928, child complained of stiffness in nape of neck which passed off, but recurred after scarlet fever in November 1929.

1930 April: Admitted to Manchester Royal Infirmary with stiffness of right arm and leg, and emaciation. Transferred to Swinton House.

1932 January: Admitted to Abergele Sanatorium.

X-ray: "Cervical and upper dorsal spine shows small pear-shaped shadow in front of 5th D.V., suggestive of abscess formation. No definite abnormality of D.V. C.V. crowded - ? one body missing at level of 5th V.C."

Lateral X-ray: "Gross disease involving C.V. 5th - 7th."

Fixation: Plaster jacket with fillet.

Progress: Good.

General condition: Fairly good.

Tuberculin reaction: $\frac{1}{1000}$ Human II

Sedimentation: Horizontal line.

CONTROL 15. J.O.N.

Age: 14 years.

Past history: Measles, German measles, whooping cough, bronchitis.

Family history: Good.

History of condition:

1933 March: Child gradually became pale and irritable, losing weight.

June: Cough developed with occasional pain in chest. Appetite poor, morning cough with sputum. Reported "T.B. "

October: Admitted to Abergele Sanatorium.

X-ray chest: "Diffused shadowing very extensive in right upper lobe and in sub-apical region of left upper lobe."

General condition: Fairly good.

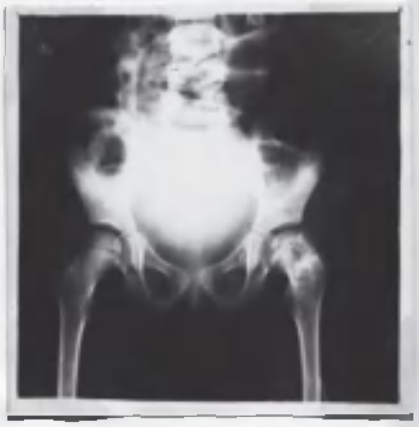
Tuberculin reaction:

Sedimentation: Vertical curve.

SECTION N

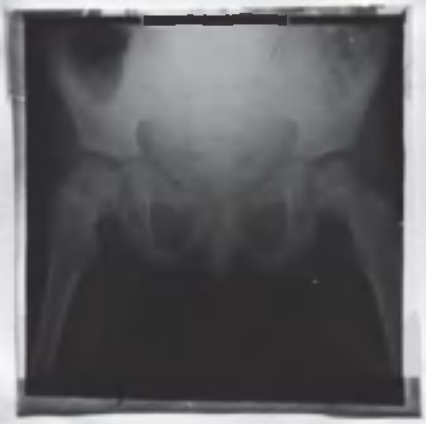
GROUP I.

CASE A.1.

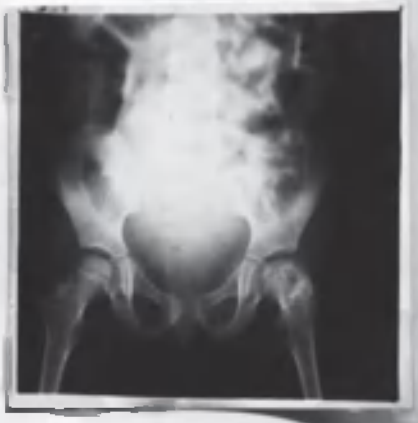


CASE A.4.

CASE A.2.



CASE A.3.



CASE A.5.

SECTION 4.

CASE A. G.L. Bedfast 2½ years.

Age: 6 years.

Past history: Convulsions, whooping cough.

Family history: No contact.

History of complaint: Onset gradual, November, 1931.

1931, August - child knocked down by cyclist. Complained of pain in left leg; unable to walk. Seen at Child Welfare Centre; referred to Ancoats Hospital. Ultra violet ray and massage ordered.

1932, January - Seen by Mr. Platt. Hip put in plaster.

April - Admitted to Abergele Sanatorium.

June - on Pyrford frame.

1934, May - Plaster spica.

This child on heliotherapy gradually developed a severe form of microcytic anaemia, which improved on administration of iron and withdrawal from the sun's rays. Coincident with the anaemia a shadow appeared on x-ray film in pelvis of right kidney. This was not present in later radiograms.

General condition: Fairly good.

Tuberculin reaction: $\frac{1}{1000}$ Human positive I

Sedimentation: Diagonal curve, shallow.

Urine examination: sp. gr. 1020, acid, crystals of feathery phosphates.

Blood counts:

June 1933	W.B.C.	10,800
	R.B.C.	2,000,000
	Hb.	34%
	C.I.	0.58

relative lymphocytosis, some hyaline and mast cells.

Gradual improvement till

June 1934	W.B.C.	6,400
	R.B.C.	5,060,000
	Hb.	76%
	C.I.	0.76

Control A. J.L. Ambulant.

Age: 6 years.

Past history: Measles, chickenpox, gastro-enteritis (in Booth Hall Infirmary).

Family history: Mother notified case of pulmonary phthisis.

History of condition:

1930, October - Slight swelling was noticed in neck glands. This was treated by

1932, May - operation was performed and glands scraped.

" October - Case re-notified "Cervical and submaxillary adenites".

" December - Admitted Abergele Sanatorium.

X-ray chest "Right hilum ill-defined, prominent calcareous nodules in lower part of hilum."

General improvement: Slow

General condition: Fair

Tuberculin reaction: $\frac{1}{1000}$ Human, positive II.

Sedimentation rate: Low, diagonal curve.

Urine examination: sp. gr. 1026, acid, feathery phosphate crystals.

CASE B. 1.

CASE B.2. (PYELOGRAM.)

CASE B. F.B. Bedfast 6 years.

Age: 13 years.

Past history:

Family history:

History of complaint:

In January, 1928, child was knocked over in street by a cyclist. Until April she complained occasionally of pain in right hip. She was seen then at Ancoats Hospital by Mr. Ollerenshaw and the hip was put in plaster.
In December, 1931, child was transferred to Abergele Sanatorium. X-ray "Extensive old-standing disease of right hip joint. Head of femur largely destroyed. Erosion of acetabulum, large calcified abscess." Tubero $\frac{1}{1,200}$ pos. $\frac{1}{1}$

Sed. Gr. low.

This girl's general condition was unsatisfactory.

In March, 1933, she had treatment for aural discharge.

In June, 1934, her urine became loaded with albumen.

X-ray examination revealed calculus formation in the left ureter.

Urea concentration was low -

Before	1 hr.	2 hrs.	3 hrs.	5 hrs.
.7%	.9%	1.3%	1.75%	0.9%

Urea in blood = 85.

U.V. rays were curtailed and ketogenic diet given.

No progress was made.

Uroselectan filmed showed no appearance at 5 mins. and 30 mins.

September, 1934. Nephrectomy of left kidney performed by Mr. Telford. Kidney tuberculosis, enlarged and adherent. Few small stones removed from ureter.

On examination these stones were found to consist of calcium and magnesium phosphate.

Total urinary output during week prior to operation

= $\frac{\quad}{\text{cx11}}$. Urine was acid, sp.gr. 1018, contained albumen and crystals - coffin lids, knife rests and needles.

Control B. E.K. Ambulant.

Age: 13 years.

Past history: Measles, whooping cough, scarlet fever, influenza.

Family history: No contact.

History of complaint: Onset was at end of 1930, gradual, with cough and lack of energy. This continued until June, 1931, when girl was seen by Tuberculosis Officer and admitted to Abergele Sanatorium.

X-ray "Extensive infiltrative disease of left lung."

Improvement was very slow, but child has now been ambulant for several months.

For 9 months she was fixed in retention jacket.

General condition: Fair.

Temperature: Occasionally unstable.

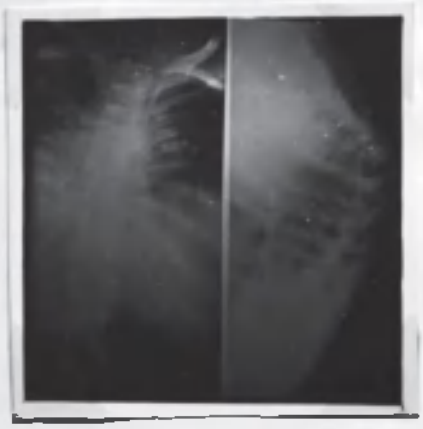
Sputum: Mucopurulent, T B. plus.

Sedimentation test: Variable.

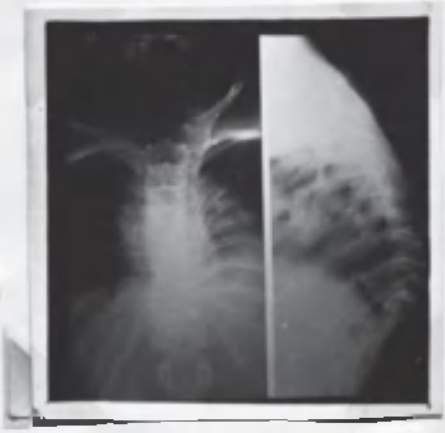
Urine examination: sp. gr. 1018, acid, oxalates present.

CASE C. 1.

CASE C. 2.



CASE C. 3.



CASE C. 4

CASE C. M.R. Bedfast 11 years.

Age: 14 years.

Past history: Nil of note.

Family history: Contact with tuberculosis.

History of complaint: The onset was gradual, in 1923, with occasional complaint of pain in back. Child was treated at home and in Pen y Coed, and admitted to Abergele Sanatorium March, 1932.

X-ray "Extensive destruction of lower dorsal segment 8th D -> 1st L. grossly destroyed, with obliteration of spaces and crowding of heads of ribs." Copious discharge from sinuses.

Fixation 1932 April - fillet spinal jacket.

" November - Berck tray.

1934 February - anterior shell.

Progress very slow, if any.

December, 1933 - intercurrent attack of acute gastric dilatation. Laparotomy performed by Mr. Telford.

General condition: Poor.

Tuberculin reaction: $\frac{1}{1000}$ Human. pos. I.

Sedimentation test: Horizontal curve.

Urine examination: sp. gr. 1020, amber, tr. albumen, organic debris.

CONTROL. C. D.R. Ambulant.

Age: 14 years.

Past history: Nil of note.

Family history: Father had phthisis pulmonalis.

History of condition: From 1927-28 child gradually lost weight and energy. She was treated for anaemia. There followed a succession of bad colds and in 1929 there was dyspnoea and palpitation.

In 1931 child had cough, with thick yellow sputum and chest was X-rayed at Pendlebury.

In 1933 she was admitted to Abergele Sanatorium. Her progress was at first slow and unsteady, but she has now been ambulant for several months.

X-ray chest: "Fine mottled shadowing central area of right lung."

General condition: Very fair.

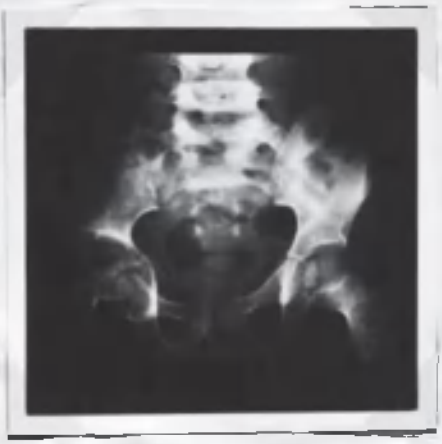
Tuberculin reaction: $\frac{1}{1000}$ Bovine. Pos. I

Sedimentation test - Straight line.

Urine: Sp. gr. 1016, alkaline, few carbonate crystals and coffin lids.

CASE D. 1.

CASE D. 4.



CASE D. 2.

CASE D. 3.

CASE D. 5.

CASE D. W.L. Bedfast 3 years.

Age: 7 years.

Past history: Measles in infancy.

Family history: Contact with tuberculosis.

History of complaint: 1931, May, child sustained an injury while at play, after which he was noticed to limp.

At Ancoats Hospital he was put in plaster.

1931 October: Admitted to Abergele Sanatorium.

X-ray chest: "Root glandular enlargement and fibrosis."
Rt. hip joint: "General osteoporosis of epiphysis and neck of right femur."

1932 August:

X-ray: "Bony architecture improved".

Fixation 1932 - August: Frame
December: Berck tray.

General condition: Poor.

Tuberculin reaction: $\frac{1}{1000}$ Human. Pos. I

Sedimentation test: Vertical curve.

Urine examination: Sp. gr. 1024. Alkaline, deposit of coffin lid crystals.

CONTROL D. J.T. Ambulant.

Age: 7 years.

Past history: Good.

Family history: Contact.

History of complaint: September 1931, pustule noticed on right cheek.

December 1931 - Operation, Skin Hospital.

November 1932 - Gradual increase in size of cervical glands. Seen at the Tuberculosis Offices.

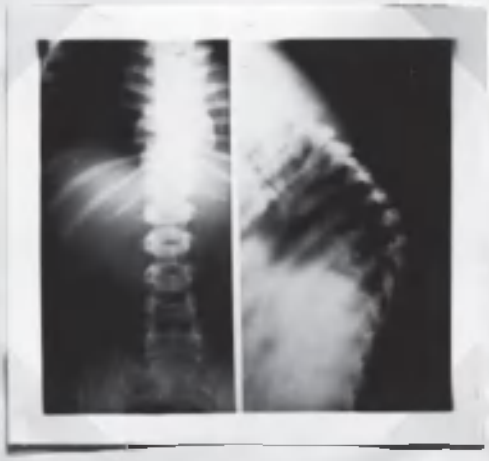
May 1933 - Admitted to Abergele Sanatorium. X-ray chest: "Congestion right hilum".

General condition: Poor.

Tuberculin reaction $\frac{1}{10,000}$ Human. Pos. I

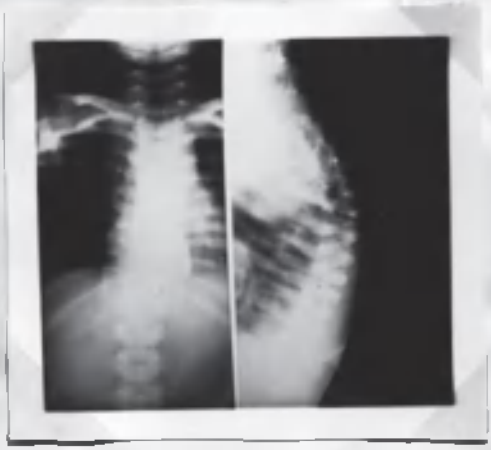
Sedimentation test: Diagonal line.

Urine examination: Sp. gr. 1024, acid, deposit of feathery phosphates.



CASE E. 1.

CASE E.2.



CASE E.3.

CASE E 4

CASE E. C.H. Bedfast 6 years.

Age: 7 years.

Past history: Diphtheria aged 3 years, measles, otorrhoea

Family history: Tuberculosis contact.

History of complaint: Onset gradual till March 1929, when a lump was noticed on child's back.

Progress: X-ray: "Extensive disease of 9, 10, 11, D. No abscess formation.

1932 February: Small saccular abscess.

1934 January: Destruction progressing.

April: ? Increase in abscess and osteoporosis.

Fixation 1931 September: Plaster jacket.

1932 February: Pyrford frame.

August: Celluloid jacket. Ambulant for 6 weeks.

1933 April: Plaster jacket with fillet.

1934 November: Mr. Telford - Hibb's operation - fixation in anterior shell.

General condition: Fair.

Tuberculin reaction: $\frac{1}{1000}$ Human. Positive I

Sedimentation test: Diagonal curve, steep.

Urine examination: Sp. gr. 1012, faint acid, deposit amorphous with few feathery crystals.

CONTROL E. R.H. Ambulant.

Age: 7 years.

Past history: Good.

Family history: Good.

History of complaint: January 1931, parents noticed gradual loss of energy and flesh.

March 1931, child complained of abdominal pain and suffered from vomiting and frequency of micturition.

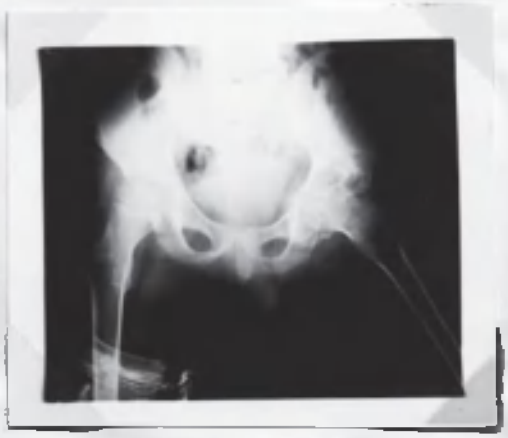
He was seen at Tuberculosis Offices and sent to Abergele Sanatorium on 30.8.32.

General condition: Very slow, irregular progress.

Tuberculin reaction: Human $\frac{1}{1,000}$ positive IV

Sedimentation test: Diagonal curve, shallow.

Urine examination: Sp. gr. 1012, faint acid, carbonate crystals.



CASE F. 1.

CASE F. 2.

CASE F. 3.

CASE F. M.K. Bedfast 4 years.

Age: 8 years.

Past history: Whooping cough, chickenpox, pneumonia in infancy.

Family history: Good.

History of complaint: 1929 November, child fell off table, thereafter developed a slight limp.
X-rayed at Ancoats Hospital: "Disease of right hip joint. Head of femur osteoporotic and flattened".

Admitted Abergele Sanatorium 13.11.31.

X-rayed December 1933: "Calcification of abscess - no increase in osteoporosis".

Fixation: 1930 July: Plaster spica.

1931 November: Pyrford frame.

1933 December: Short plaster spica.

General condition: fairly good.

Tuberculine reaction: Human $\frac{1}{1,000}$ Pos. IV.

Sedimentation test: Horizontal curve, straight line.

Urine examination: Sp. gr. 1018, ft. acid, amorphous deposit and knife rest crystals.

CONTROL F. R.R. Ambulant.

Age: 8 years.

Past history: Measles, bronchitis, pneumonia, chickenpox.

Family history: Good.

History of complaint: Unsatisfactory health from birth.

1927 - ? Spinal disease - pronounced well.

1929 - Abscess neck - in Booth Hall Infirmary.

1930 - Fluid right side of chest - Gartside Street.

1932 - Distension of abdomen. Seen at Tuberculosis Dispensary. Transferred to Abergele Sanatorium.

General condition: Gradual improvement.

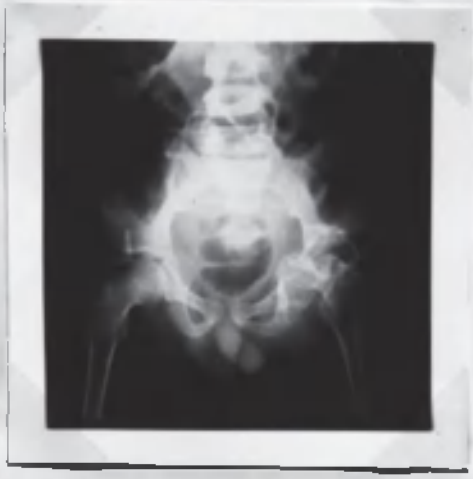
Tuberculin reaction: $\frac{1}{1000}$ Pos. III

Sedimentation test: Diagonal curve, deep.

Urine examination: Sp. gr. 1025, ft. acid, trace of albumen. Gran. crysts and bacilli.

CASE G. 1.

CASE G. 2.



CASE G. 3.

CASE G. D. McH. Bedfast 4 years.

Age: 9 years.

Past history:)
Family history:) Nil of note.

History of complaint: In June 1930, child fell and bruised right side. Following this he was fretful, had pain on moving leg and walked with a limp.

9.6.30. X-rayed at Ancoats - Hip put in plaster.

February 1931: Removed to Swinton House and plaster again applied.

X-ray: "Head and back of femur osteoporitic joint space much narrowed, acetabulum rarefied."

January 1932: Child transferred to Abergele Sanatorium. Progress was poor and an abscess developed and discharged by sinus formation after several aspirations.

August 1932: There was a pathological fracture of humerus.

October 1933: Fixation on Pyrford frame.

Recently there had been definite evidence of re-calcification.

General condition: Poor.

Tuberculin reaction: $\frac{1}{1000}$ Bovine Pos. III.

Sedimentation test: Diagonal curve, steep.

Urine: Sp. gr. 1012, acid, coffin lid and carbonate crystals.

CONTROL G. T.M. Ambulant.

Age: 9 years.

Past history: Measles, pneumonia, several attacks of quinsey.

Family history: Contact with tuberculosis.

History of complaint: In December 1929, child caught cold and suffered from cough and sweats. He was taken to Gartside Street in 1930 and prescribed U.V.R. treatment.

May 1930, he was examined at Hardman Street, and diagnosed "T.B. peritonitis".

December 1933: Admitted to Abergele Sanatorium.

Progress has been very slow and uncertain.

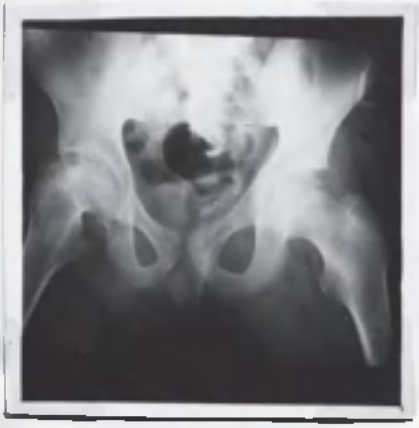
General condition: Poor.

X-ray chest: "Calcareous nodules in hilum."

Tuberculin reaction: $\frac{1}{1000}$ Human, Positive III.

Sedimentation test: Diagonal curve, steep.

Urine examination: Sp. gr. 1020, deposit of am. urate.



CASE H.1.

CASE H.2.

CASE H.3.

CASE H. H.P. Bedfast 1½ years.

Age: 12 years.

Past history: Pneumonia, measles, chickenpox in infancy.

Family history: Mother had Tb. bone of foot in January 1933.

History of complaint: In 1931, child collapsed while at drill in school.

Onset: Following this there was occasional languor till 1932, when the boy complained of acute abdominal pain, followed by vomiting and violent pain in right hip and inability to put full weight on right leg.

November 1932 - In Booth Hall Infirmary. X-rayed: "No abnormality".

January 1933 - Again X-rayed: "Some porosis and early erosion in the upper and inner part of the diaphysis near the epiphyseal line. ? Early tuberculosis."

The hip was put in plaster and child taken home in February 1933.

December 1933 - Admitted to Abergele Sanatorium.

Progress: January 1934. X-rayed "Extensive disease right hip joint with complete obliteration of the joint space, with destruction of head of femur. Greater trochanter impinging almost on ilium."

June 1934. X-rayed "Some evidence of sclerosis."

General condition: Fairly good.

Tuberculin reaction: Negative to Human and Bovine $\frac{1}{10}$

Sedimentation: Gradual curve.

Urine examination: Sp. gr. 1024, alkaline, trace of alb. organic debris, knife rest crystals.

CONTROL H. E.W. Ambulant.

Age: 12 years.

Past history: Measles and diphtheria, aged 3 years.

Family history: No tuberculosis in family.

History of complaint: In 1928 mother noticed that child was gradually losing weight. He complained occasionally of pain between shoulders and had several attacks of bronchitis and swollen neck glands.

Previous treatment: August 1929, in Booth Hall Infirmary, thereafter child was examined by the Tuberculosis Officer and admitted to Abergele Sanatorium in September 1933.

Progress: Following this, progress was excellent.

X-ray of lungs: "Large hilar shadows".

General condition: Very good.

Sputum, watery: T.B. minus.

Tuberculin reaction: Negative on admittance $\frac{1}{10}$ Human Bovine.

Positive later $\frac{1}{20}$ Human IV Bovine II

Sedimentation test: Straight line.

Urinary examination: Sp. gr. 1010, acid, no abnormal constituents. No sediment.

CASE I. 1.

CASE I. 2.

CASE I. 3.

CASE I. J.S. Bedfast 11 years.

Age: 13 years.

Past history:)
) Nil of note.
Family history:)

History of complaint: Onset gradual in 1923, limp noticed. Boy admitted to Booth Hall Infirmary, fixed on frame.

1931 June. Admitted to Abergele Sanatorium.

X-ray: "Extensive disease of acetabulum and ilium".

Abscess and sinus formation.

1933 February. Sinuses scraped.

X-ray: "Considerable formation of new bone".

1934 June. X-ray: "Increased sclerosis in ilium, ankylosis not quite sound."

Fixation 1931 October: Listen with extension.

1932 January: Double spica.

General condition: Fair.

Tuberculin reaction: $\frac{1}{20}$ Human - pos. IV

Sedimentation: Sp. gr. 1022, acid.
Crystals of feathery phosphates and oxalates.

CONTROL I. O.S. Ambulant.

Age: 12½ years.

Past history:)
) Nil of note.
Family history:)

History of complaint: Onset gradual, during 1927. Occasional abdominal pain and vomiting.

1930 April: Had U.V.Ray treatment at Gartside St.

December: Notified "tabes mesenterica".

1933 April: Admitted to Abergele Sanatorium.

X-ray: "Shadows right hilum".

Improvement very slow.

General condition: Fair.

Tuberculin reaction: $\frac{1}{1000}$ Bovine. Positive III

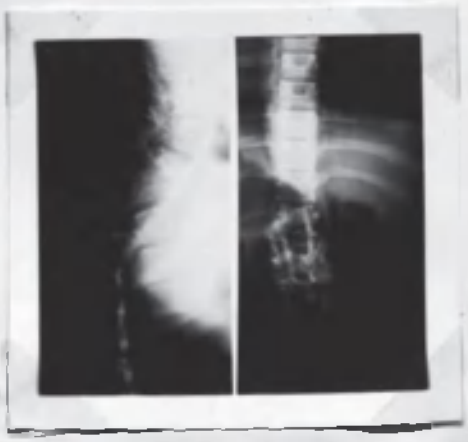
Sedimentation rate: Diagonal curve.

Urine examination: Sp. gr. 1012, acid, trace of epithelial debris.

CASE. J. 1.

CASE. J. 2.

CASE. J. 3.



CASE. J. 4.

CASE J. F.T. Bedfast 4 years.

Age: 13 years.

Past history: } Nil of note.
Family history: }

History of complaint: Onset was very gradual, with child thin and languid, until a lump was noticed in back in November 1930. Boy was seen at Manchester Royal Infirmary, put on frame.

X-ray: "2nd L. vertebra destroyed. 3rd L.V. extensively eroded."

June 1931 - Admitted to Abergele Sanatorium.

Fixation September 1931 - Berck tray with hyperextension.

August 1932 - Lumbar plaster.

1934 - X-ray "Evidence of recalcification, still some osteoporosis."

General condition: Fair.

Tuberculin reaction: Human $\frac{1}{100}$ Positive II.

Sedimentation test: Vertical curve.

Urinary examination: Sp. gr. 1022, neutral, needle shaped crystals.

CONTROL J. J.H. Ambulant.

Age: 13 years.

Past history: Nil of note.

Family history: Mother had phthisis pulmonalis.

History of complaint: Onset was acute in November 1928, when patient had a feverish cold with a very high temperature. Two weeks later a cough developed and he was admitted to Booth Hall Infirmary where he was reported to have a "Collapse left lung, slowly diminishing".

Since then his condition has slowly improved and he is now ambulant.

X-ray chest: "Nil in parenchyma. Scattered glandular nodules in chest".

General condition: Good.

Tuberculin reaction: $\frac{1}{10,000}$ Human III.

Sedimentation test: Horizontal line.

Urine examination: Sp. gr. 1018, acid, few hyaline and granular casts, epithelial debris, few oxalates.

CASE K.1.

CASE K.4.

CASE K.2.

CASE K.5.

CASE K.3.

CASE K. M.B. Bedfast 2 years.

Age: 14 years.

Past history: Measles and pneumonia in infancy.

Family history: Paternal grandfather had phthisis pulmonalis.

History of complaint: In June 1932, fell from off a wall.

Onset: In July the hip became painful, causing him to limp. This was X-rayed in Manchester Royal Infirmary and boy sent home to remain in bed for a week.

August 1932: Complaint of further pain, with increased difficulty in walking. Boy admitted to Booth Hall Infirmary, where plaster splints were applied.

X-ray: "Suspicious area of bone porosis in upper end of diaphysis near epiphyseal line". and later "commencing bony ankylosis".

Boy transferred to Abergele Sanatorium.

June 1933. "Osteoporosis of bones of left hip joint, irregular translucent area below epiphyseal line of neck should be watched."

October 1933. "Rarefied area less evident".

November 1933. Complaint of lumbar pain, with tenderness and haematuria. This followed a pathological fracture of femur. The urine at this stage showed increased deposit of oxalate crystals and contained albumen and blood.

February 1934, complaint of rt. lumbar pain, with doubtfully palpable kidney. No abnormality found in urine.
Pyelogram - "No abnormality".

General condition: Good.

Tuberculin reaction: Negative $\frac{1}{100}$ Human and Bovine.

Sedimentation test: Gradual curve.

Urinary examination: Sp. gr. 1020, acid, no abnormal constit.

CONTROL K. J.B. Ambulant.

Age: 14 years.

Past history: Measles in infancy.

Family history: Nil of note.

History of complaint: In 1928 child complained occasionally of abdominal pain and was languid. He was seen at Gartside Street and an operation performed at Pendlebury - removal of appendix and mesenteric glands - followed by a course of sunlight treatment at Gartside Street. Later he was treated at the Tuberculosis Dispensary for "bronchial exudation".

In 1933 he was admitted to Abergele Sanatorium, following which his progress was steady and good.

X-ray chest: "Nil gross".

General condition: Very good.

Tuberculin reaction: On admission Pos. $\frac{1}{10,000}$ H. IV B. III

Later: $\frac{1}{10,000}$ H. III B. IV.

Sedimentation test: Horizontal line.

Urine examination: Sp. gr. 1018, acid, trace mineral debris.

CASE L.1.

CASE L.2.

CASE L.3.

CASE L. S.M. Bedfast 10 years.

Age: 15 years.

Past history: See history of complaint.

Family history: Nil of note.

History of complaint: In 1924 child was in Booth Hall Infirmary with tuberculosis of hip and of right humerus. He was treated with fixation on a frame.

February 1932 - transferred to Abergele Sanatorium, where fixation was continued.

February 1933 - sinuses opened and bone scraped.

November 1934 - Osteotomy performed for talipes.

During this time there has been steady, slow improvement, with decreasing discharge from sinuses and increasing ankylosis of hip joint.

X-ray: "Head and neck of left femur completely destroyed, acetabulum eroded, with dislocation."

Sinuses

Later: "Ankylosis improving. Discharge persisting".

Fixation 1931 September - extension on tray.

1934 June - plaster spica.

General condition: Fair.

Tuberculin reaction: $\frac{1}{1,000}$ Human. Positive IV.

Sedimentation test: Diagonal line, steep.

Urine examination: Sp. gr. 1022, acid with organic debris and needle and coffin shaped crystals.

CONTROL L. J.G. Ambulant.

Age: 15 years.

Past history: Good.

Family history: Good.

History of complaint:

1933, boy caught cold, following which he became languid, lost weight, and developed a cough. Examination at Manchester Royal Infirmary revealed fluid on chest, and the fluid was reported T.B. positive.
He was transferred to Abergele Sanatorium in December 1933.

X-ray: "Homogeneous shadowing lower half of right lung, more dense in lateral half, encysted".

His progress has been good and he has been ambulant now for six months.

General condition: Fairly good.

Tuberculin reaction: Positive $\frac{1}{10,000}$ Human I.

Sedimentation test: Horizontal line.

Urine examination: Sp. gr. 1018, acid, oxalate crystals very plentiful in deposit.

COMPARATIVE X RAYS.

SECTION IV.

GROUP I.

A.

A. & CONTROL.

B.

B. & CONTROL.

C.

C. & CONTROL.

D.

D. R CONTROL.

193M

E

E. & CONTROL.

F.

F. & CONTROL.

G.

G. & CONTROL.

H.

H & CONTROL.

I.

I. & CONTROL.

J.

J. & CONTROL.

206

K.

K. & CONTROL.

L.

L. & CONTROL.

SECTION IV

SECTION IV

GROUP. II.

1.

1. & CONTROL.

CASE 1. M.G. female.

Age: $4\frac{10}{12}$ years.

Past history: Broncho pneumonia, whooping cough, measles 1934, followed by poor health, ? rickets.

Family history: No contact.

History of complaint: Onset early 1935.

Child complained of pain in right knee and hip. She walked with a limp. She was X-rayed at the Manchester Royal Infirmary, but showed no evidence of tuberculosis.
November 1935, pain increased, child attended Gartside Street Dispensary and was referred to the Lancasterian School as "rather acute T.B. disease of hip".

June 1936. Admitted to Booth Hall Hospital.

X-ray: "Erosion of head of femur and more so of acetabulum".
The hip was put in plaster and child transferred to Abergele Sanatorium.

23.6.36. - Tuberculin $\frac{1}{10,000}$ H. I B. I

X-ray: 15.7.36. "Very advanced porosis of head and neck of right femur, and of central and upper part of acetabulum. Head of femur losing outline and is evidently absorbing rapidly".

Treatment: Extension on Abergele frame.

[illegible]

[illegible] 8

[illegible] splints

[illegible] I May
[illegible] tion.

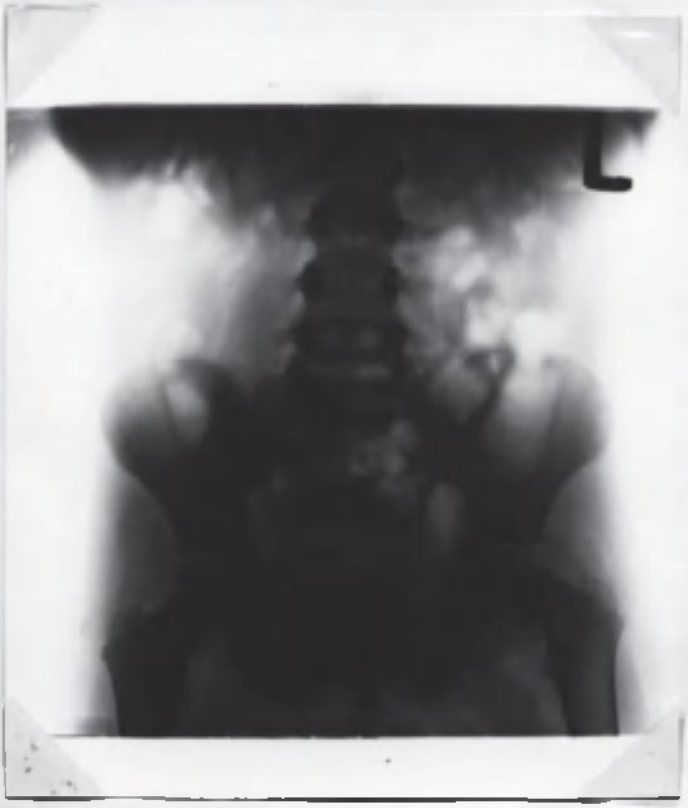
[illegible]

[illegible]

Tuberc[illegible]

X-ray [illegible]
of [illegible]
bones [illegible]
Epiph[illegible]
but [illegible]

[illegible] Bony



2.

2. & CONTROL.

CASE 2. M.H. female.

Age: $5\frac{1}{2}$ years.

Past history: Whooping cough.

Family history: No contact.

History of complaint: Onset January 1936. Complaint of pain in left groin, with swelling. Limp when walking. This was treated at home with iodis.

March till May 1936, the condition was treated as rheumatism.

29.5.36. Examined by Mr. Telford, "T.B. hip".

7.6.36. Admitted to Abergele Sanatorium.

Tuberculin test: $\frac{1}{10,000}$ H. I B. I

X-ray pelvis: "Irregular osteoporosis of neck of left femur, evidence of new bones and slight lipping of neck. Epiphyseal head of femur altered in shape, but not eroded. No loss of joint space."

Treatment: Extension on frame.

3.

3. & CONTROL.

CASE 3. M.K. male.

Age: 4 years.

Family history: No contact.

Past history: Cervical adenitis.

History of complaint: Onset December 1934.

Child fell down a flight of steps, injuring right knee. Began to drag let when walking.

February 1935: Taken to Roby Street and Ancoats Hospital.

May 1935: X-ray of knee and hip at Manchester Royal Infirmary. Plaster spica applied.

October 1935: Admitted to Abergele Sanatorium. X-ray: "Very marked thickening of the neck of right femur, with flattening and rarefaction of epiphyseal head. No acetabulum erosion".
? Early tuberculosis.

Tuberculin: $\frac{1}{10,000}$ H. I
B. I

Treatment: Immobilisation on Abergele frame.

4.

4. & CONTROL.

CASE 4. K.H. male.

Age: $4\frac{2}{12}$ years.

Family history: Mother died of pulmonary phthisis.

Past history: Measles, pneumonia, whooping cough.

History of complaint: Onset April 1935 - child noticed to be limping with right leg, complaint of pain at times.

July 1935. Admitted to Ancoats Hospital. Right hip flexed and rigid at 20°, fixed on Thomas' frame.

X-ray: "Area of destruction on antero-internal aspect of neck of right femur, surrounded by area of sclerosed bone, pointing to quiescent tuberculous infection right femur."

Plaster applied - child allowed home 21.10.35.

December 1935. Transferred to Abergele.

X-ray: "Slight subluxation of hip and some absorption of femoral epiphysis - half moon area lower aspect of neck, suggests excavation."

Tuberculin: $\frac{1}{10,000}$ H. I B. II

Treatment: Immobilisation and extension on Abergele frame.

5.

5. & CONTROL.

CASE 5. W.R. Male.

Age: 4¼ years.

Family history: Father died of pulmonary phthisis.

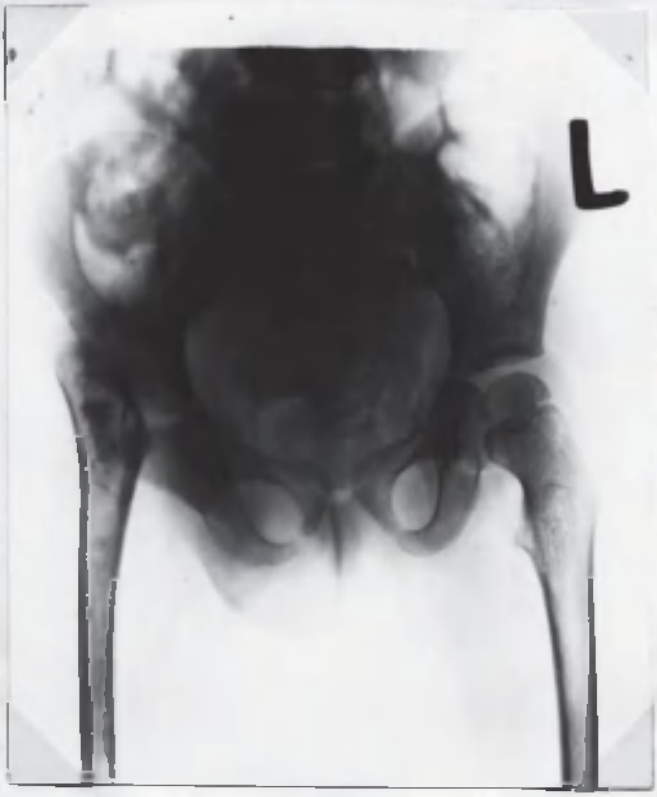
Past history: Cervical adenitis February 1935.

History of complaint: ? Onset May 1935, when child was seen to drag right leg. Probably dated from fall in February, when child was admitted to Northern Hospital, since when there was occasional complaint of pain in right knee.

Admitted to Abergele Sanatorium 22.5.36.

X-ray: "Very acute disease of right hip. Some absorption and gross osteoporosis of head and neck of femur. Some dislocation outwards and commencing acetabular absorption."

Treatment: Extension on Abergele frame.



6.

6. & CONTROL.

CASE 6. J.P. Male.

Age: $5\frac{10}{12}$ years.

Family history: No contact.

Past history: Measles, whooping cough, chickenpox, pulmonary tuberculosis, 1932.

History of complaint: Onset September 1933, child in Booth Hall Hospital, suspected of Tuberculosis of right hip. Put on Thomas' frame.

X-ray: July 1935. "Suggests occurring ankylosis between upper end of femoral shaft and acetabulum. No evidence of bone disease in dorso-lumbar spine."

September 1935: Admitted Abergele Sanatorium.

X-ray: "Right hip joint shows gross destructive disease, extensive upward destruction of acetabulum. Femur subluxated with almost complete destruction of femoral head and neck. Large translucent area extending into femoral shaft with central area of denser shadowing - ? Cavity."

Tuberculin: $\frac{1}{10,000}$ H. I B. I

Treatment: Extension in Abergele frame.

CASE 8. D.S. male.

Age: $6\frac{1}{12}$ years.

Family history: No contact.

Past history: Measles.

History of complaint: Child was knocked down by motor car in October 1933.

June 1932. Complaint of pain in neck, head began to droop forward. X-rayed Anocats. Massaged for six months. Then night terrors began.

February 1936. School Medical Officer noticed slight prominence of 9th and 10th D.V. referred to Lancasterian School, seen by Mr. Telford.

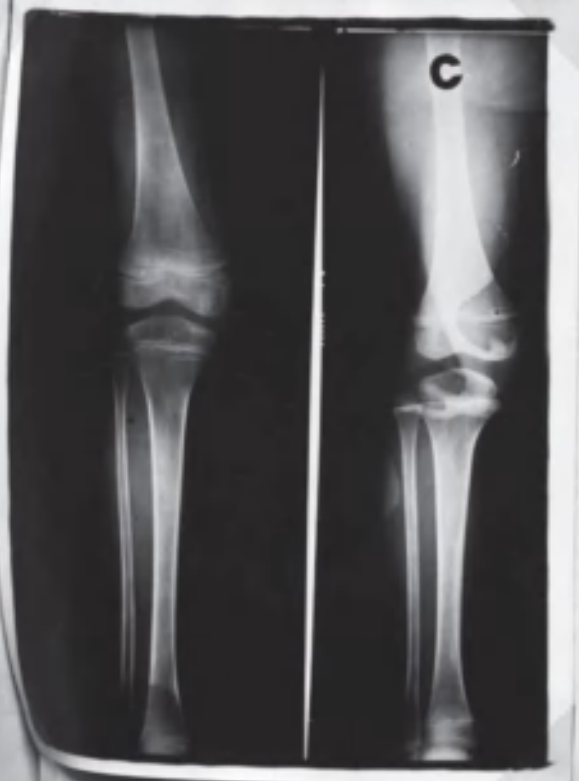
April 1936. Admitted Abergele Sanatorium.

X-ray: "Collapse together of 9th and 10th D.V. Alignment good. Large posterior spinal abscess. Efficient fusion of eroded vertebral bodies in progress. Very small gibbus formation.

Tuberculin: $\frac{1}{10,000}$ H. I B. I

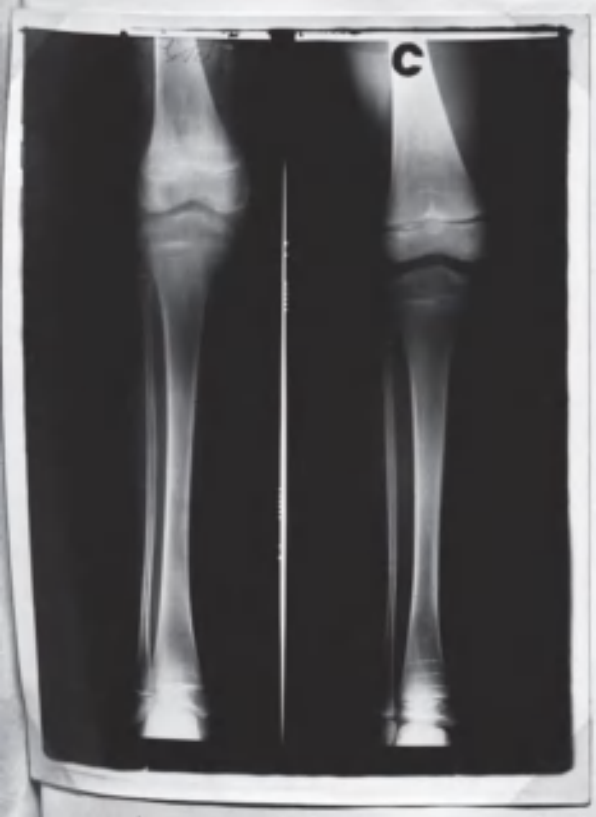
Treatment: Anterior shell with gibbosity pad.

9.



9. & CONTROL.

10.



10. & CONTROL.

CASE 9. T.P. male.

Age: $6\frac{2}{12}$ years.

Family history: No contact.

Past history: Measles and rheumatism.

History of Complaint: July 1935, child fell off bi
complained of pain in groin
left knee, taken to Gartside

April 1936. Mr. Platt X-rayed at M.R.I.
"Tuberculosis of 4th and 5th Lumb
Put on plaster bed.
Transferred to Abergele Sanatorium

X-ray: "Erosion and partial fusion of 4th
and 5th Lumbar bodies, slight tilt
of upper spine to left. Disease
appears active."

X-ray: August. "Bilateral abscess".

Tuberculin: $\frac{1}{10,000}$ H. I
B. I

Treatment: Anterior shell and gibbosity block.

B.

B. & CONTROL.

CASE 7. J.B. Male.

Age: 6 years.

Family history: Mother died of pulmonary phthisis 193

Past history: Measles 1931.

History of complaint: Onset 1932 Hip.

Onset 1933 Spine.

May 1932, limp and pain in right knee. Child examined at Gartside Street. Shortening noticed and surgical boot prescribed.

May 1933, swelling noticed in dorsal region.

June 1933, X-rayed: Admitted Pendlebury Hospit "Pleural thickening left chest".

October 1934, transferred to Booth Hall Hospital.

Admitted Abergele Sanatorium 18.10.35, on double abduction frame, extension below left knee.

X-ray: Spine. "Extensive disease, 5th, 6th, bodies involved, no abscess. Extensive destruction and absorption, very large s

X-ray: Hip. "Destruction of head left femur, erosion of acetabulum, little displacem Appearance of active disease."

Tuberculin $\frac{1}{10,000}$ H. I B. III

Treatment: Posterior shell with extension for left

7.

7. & CONTROL.