ACUTE HAEMATOGENOUS OSTEOMYELITIS: A REVIEW OF 300 CASES TREATED DURING 1952-1959*

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Before the introduction of penicillin, of every 100 children afflicted with osteomyelitis 25 died and 50 more were seriously crippled for life. Although the condition has now lost its lethal implications, it remains a potent cause of serious disease, especially in children.

In 7 years 300 patients were treated at Groote Schuur Hospital and the Red Cross War Memorial Children's Hospital, Cape Town, and judging from other published series this appears to represent the highest incidence of osteomyelitis in the world. With an average stay in hospital of 44·5 days at a cost, in Cape Town, of £6 a day, this disease has cost the taxpayer over £80,000 in 7 years. So relatively frequent is the condition in Cape Town that we have a special 'osteitis ward' at the Children's Hospital.

The disease occurs mainly in children, and the plotted age incidence show peaks at 6 and 10 years of age, declining rapidly in the teens but with a high incidence in infants (Fig. 1). Male cases predominate over the female in the proportion of 2 : 1 and this is usually attributed to the greater activity and adventurousness and the consequent increased liability to trauma on the part of boys as compared to girls. In this series most of our patients were Coloured with a small sprinkling of Bantu. In America, however, it has been noted that the disease is less frequent in Negro children than White.

It has long been observed that osteomyelitis is a disease of the poor[1]—Stevenson[2] pointed out that it was rarely seen in private practice in Glasgow—and this is borne out in Cape Town, where orthopaedic and general surgeons in private practice see very few cases.

It is of interest that osteomyelitis is unknown in the lower animals.[2]

In the present series the disease was seen in greatest numbers in September, with January and March next in frequency (Fig. 2). It is convenient that there are not many cases in the winter because in that season we admit a large number of burns, and both conditions require skilled and attentive nursing.

Fig. 1. Age incidence.

Causation

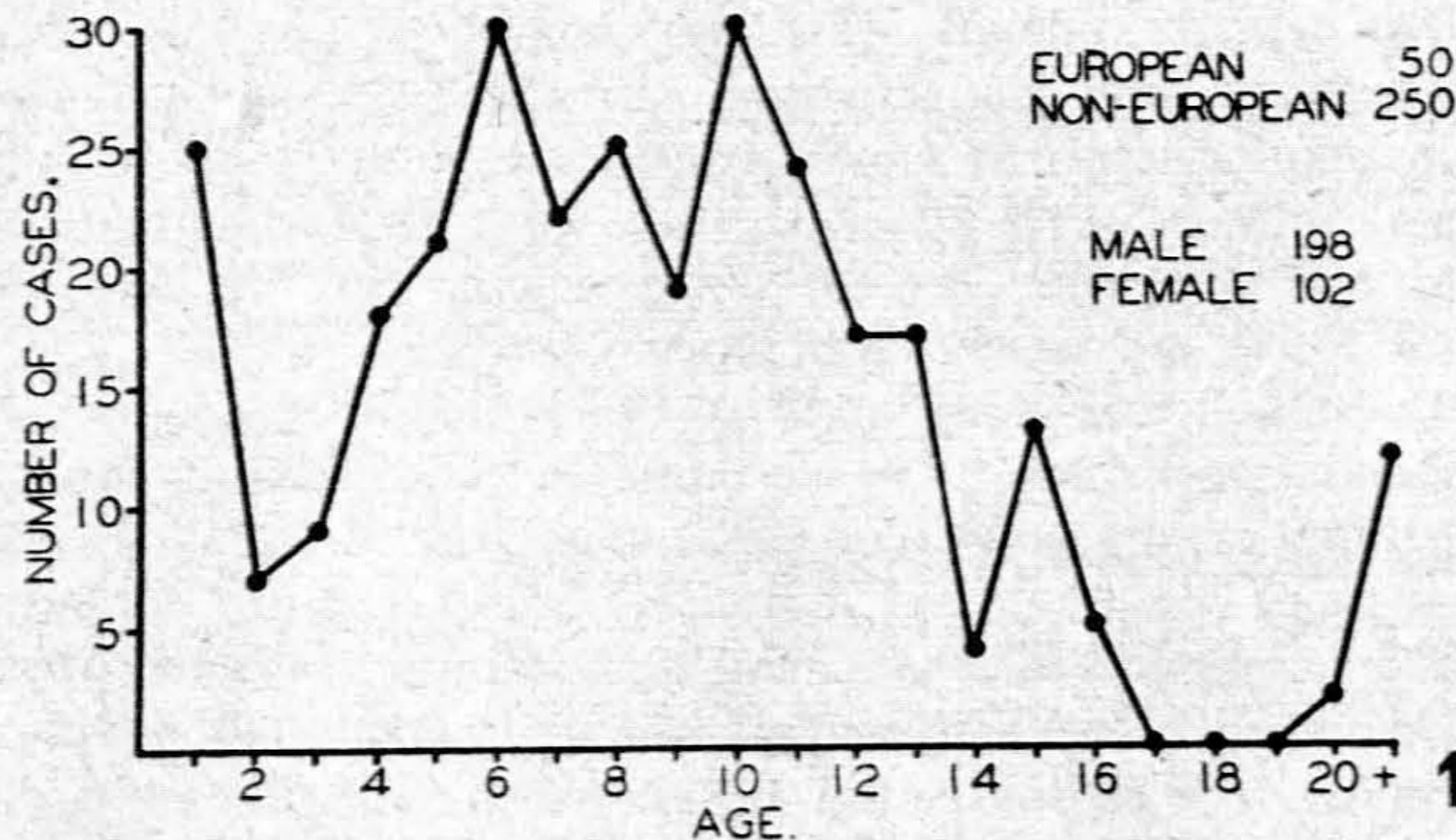The aetiology of osteomyelitis remains obscure, notwithstanding much work that has been done on the blood supply
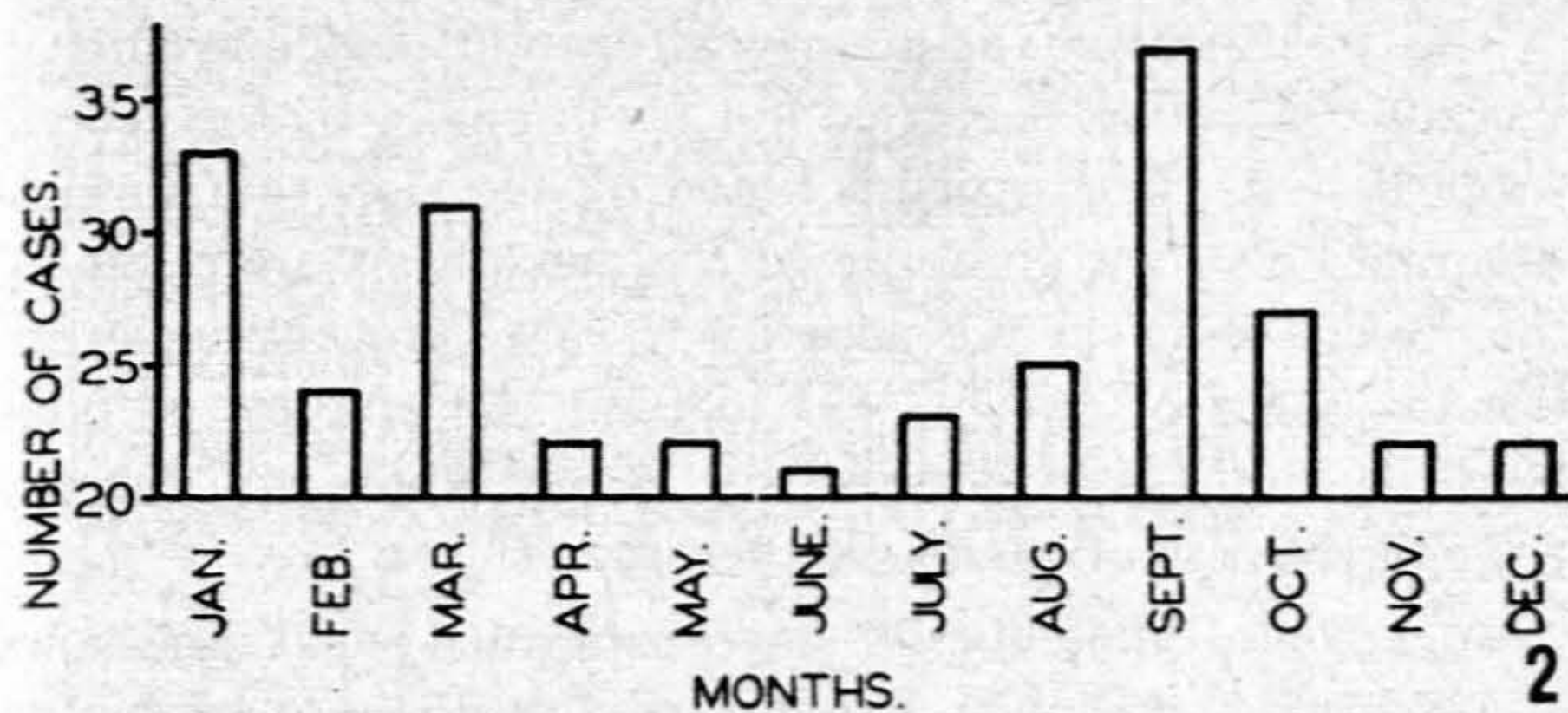
Fig. 2. Seasonal incidence.

of long bones and the reasons for the site of election in the metaphysis.

In 1922 Starr[3] emphasized the metaphyseal origin of the overwhelming majority of cases of haematogenous osteomyelitis. In 1929 Harris[4] alleged, on experimental grounds, that the vessels of the diaphysis are in effect end-arteries and that the phenomena of the disease in the metaphysis are essentially infarctive. The usual reason given for infection at the end of a long bone is that the greater vascularity is responsible for vascular stasis. It has also been shown, however, that there is poor phagocytosis at the end of a long bone.[5] Lewin and Schuman[6] indicate potential anastomoses between epiphyseal, metaphyseal and diaphyseal vessels.

Trauma has been incriminated in the aetiology. In the present series (Table I) a history of trauma was obtained in 37·6% of cases, care being taken to include only those cases where the trauma, judging by the case notes, was significant. This figure of 37·6% is in accordance with the findings of other writers.

If trauma is in fact important in aetiology, it might be expected to be just as likely to cause subperiosteal damage and infection as metaphyseal. A blow to the periosteum would

TABLE I

	No. of cases	Percentage
History of trauma ..	119	37·6
Preceding lesion ..	46	15·3
Significant regional lymphadenopathy	108	36

destroy tissue and release histamine, which in turn acting as a dilator of the vessels would retard circulation and allow bacteria to be deposited in the affected area. Farr[7] belittled the role of trauma, pointing out that in no case has osteomyelitis followed a simple fracture of the bone.

Preceding lesion (Table I). The pathogenesis of the disease presupposes a bacteraemia or septicaemia arising elsewhere in the body, and in this series, evidence that was in any way tenuous being ignored, 15·3% of the patients had some preceding septic lesion. I have not estimated the corresponding percentage in our population at large, but should not be greatly surprised if it approximated the same figure.

Lymphadenopathy (Table I). In this series, 36% of cases showed significantly enlarged palpable and tender regional lymph nodes. Enlarged lymph nodes have never been featured in the clinical picture of acute osteomyelitis in other series. In some of our cases, however, they may have been secondary to another infected focus in the same limb.

The *erythrocyte sedimentation rate* (ESR) is an important, indeed essential, investigation in the treatment of acute osteomyelitis. The initial readings in the cases in this series are reflected in Fig. 3. Neither the initial reading nor the
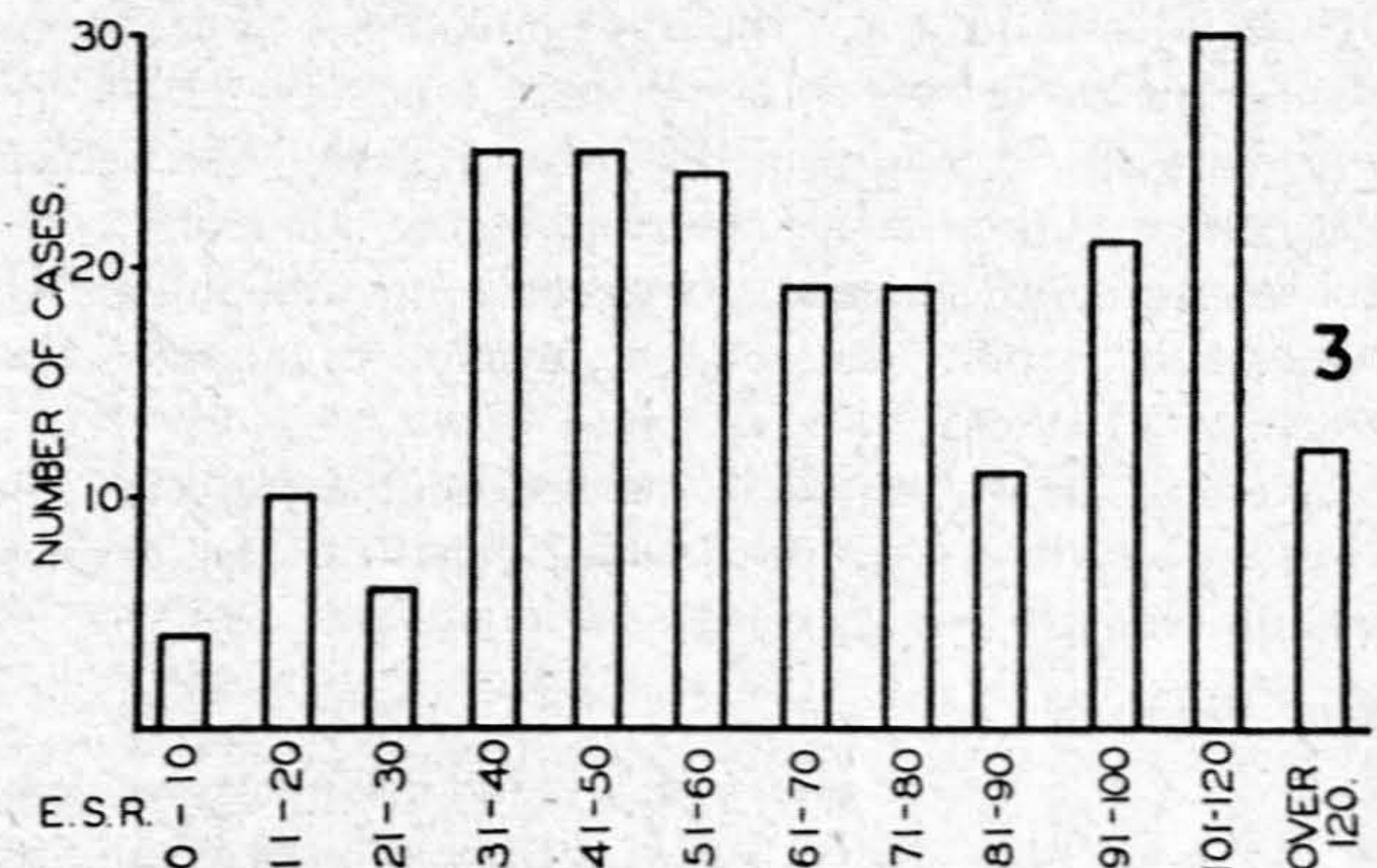

Fig. 3. Erythrocyte sedimentation rates: initial readings (mm. in the first hour—Westergren).

time taken for the ESR to return to normal seems to be of any prognostic import. However, the ESR is the investigation *par excellence* which we use to guide us in treatment. The average case took 52·5 days to reach an ESR of 20 mm. or less (first hour—Westergren).

The Organism

It is generally accepted that osteomyelitis is but one complicating aspect of a septicaemia which should reveal the causative organism on blood culture. Not all our cases had this done or recorded, but of 180 blood cultures 102 (56·6%) were positive and the remainder negative. The incidence of contaminants in the cultures was exceedingly small—the result of meticulous asepsis in procuring the specimens.

Table II shows the organisms isolated either from the blood or the pus, and their sensitivity to antibiotics. It will be noted that in 174 cases (96%) the organism was *Staphylococcus aureus*. Recently more and more papers have been appearing on the problem of infection in hospital and the increasing frequency of staphylococcal complications, particularly

TABLE II. ORGANISM AND SENSITIVITY

Organism	Sensitivity	No. of Cases	Per-centage
Staphylococcus aureus	All the antibiotics	146	81·1
,,	All except penicillin	17	9·4
,,	All except penicillin and sulphatriad	4	2·2
,,	Chloromycetin and erythromycin only	7	3·9
Streptococcus viridans	All the antibiotics	1	
,,	All except sulphatriad	1	
Beta-haemolytic streptococcus	All the antibiotics	3	
Klebsiella aerogenes	All except penicillin	1	
Proteus	Chloromycetin and streptomycin only	1	

infection with staphylococci insensitive to penicillin. It comes as a refreshing surprise, therefore, to discover that the overwhelming majority of our cases were caused by a staphylococcus aureus sensitive to the by now almost archaic penicillin. Many of our cases, unfortunately, come to us late, often not before someone has tried a 'shot' of penicillin. The possible result of such misguided and inadequate therapy is twofold: First it may sterilize the blood (and hence the blood culture) but not the metaphyseal abscess; and secondly the infecting organism may develop insensitivity to penicillin.

Of the 17 cases in which the staphylococcus was sensitive to all the antibiotics tested at the time (and this varied from year to year) except penicillin, the majority had received one or more injections of penicillin before admission.

The staphylococcus sensitive to chloromycetin and erythromycin only is our local resident hospital organism—it was isolated in 7 cases.

We have been fortunate in our series in having had only 2 cases in which a streptococcus viridans was the organism responsible.

Bones Involved

Many bones were involved, and the maximum incidence, in this series as in others, was at the upper ends of the tibiae and the lower ends of the femora. Next in frequency were the lower ends of the tibiae and the upper ends of the femora (Fig. 4). There were 22 cases of osteomyelitis of the neck of the femur.

Clinical Picture

The clinical picture of acute haematogenous osteomyelitis is well known and hardly needs to be dwelt upon. The toxic-looking child, often desperately ill, with a limb immobile, hot; tender and swollen— all these are the classic signs of acute osteomyelitis, familiar to everyone.

I should, however, like briefly to mention the condition of osteomyelitis of the neck of the femur—a site of the disease which has been responsible for many misdiagnoses and often disastrous results. We frequently have these cases in children who have initially been labelled poliomyelitis, irritable hip, arthritis of the hip, rheumatic fever, even typhoid, pyrexia of unknown origin, etc. The condition is difficult to diagnose, especially where general signs predominate and local signs are minimal. Failure to be aware of the condition leads to delay in diagnosis and treatment, and lifelong crippling aftermaths.
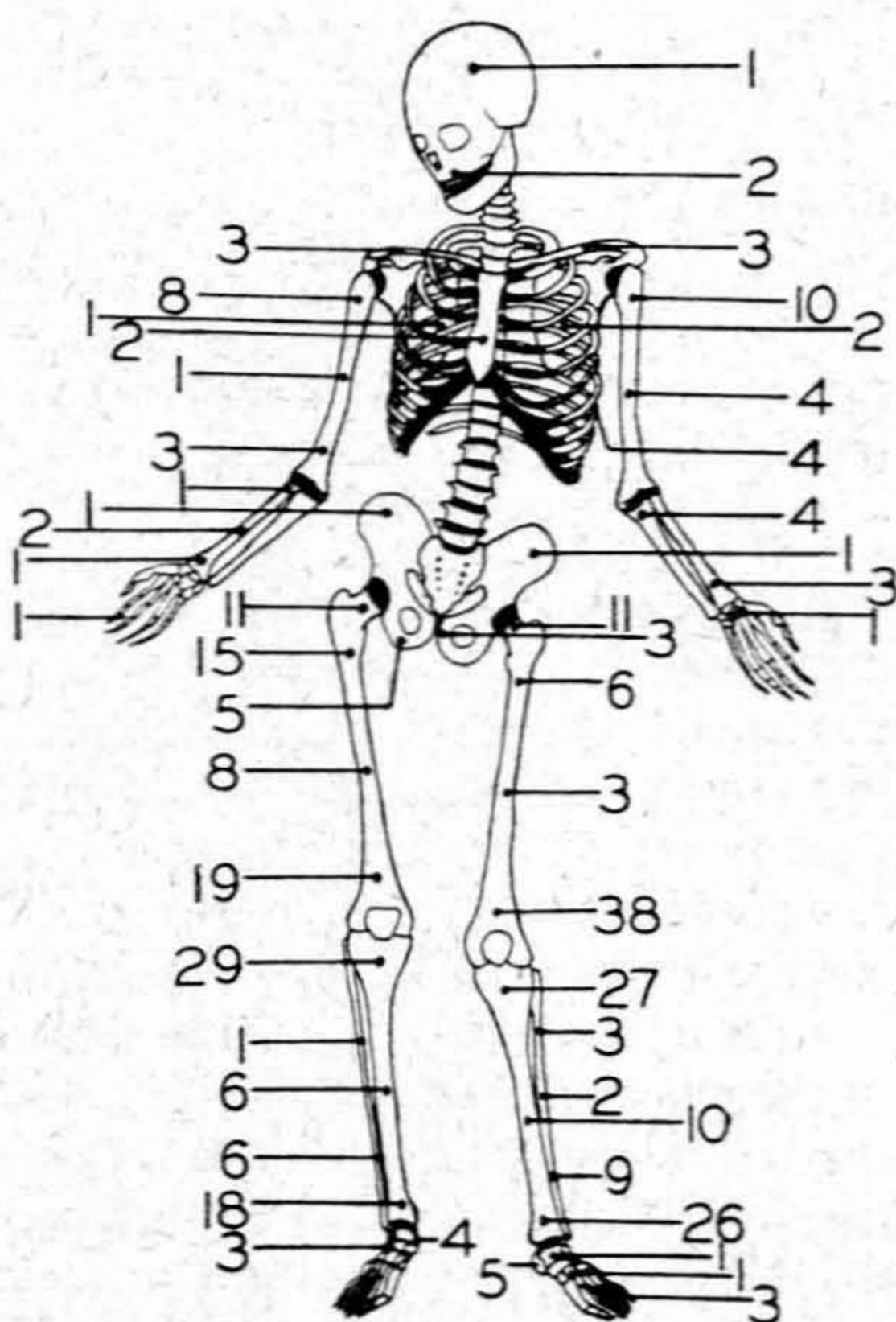

Fig. 4. Frequency of cases in the different bones of the body.

TREATMENT

Much has been written on the treatment of acute osteomyelitis, especially since the advent of penicillin. Agerholm et al.,[8] Trueta et al.,[9] and Tucker et al.[10] have held that penicillin treatment has not eliminated the need for extensive emergency surgery. Altmeier et al.,[11] Kenney,[12] Hudson,[13] and others, on the other hand, maintain that emergency surgery is usually unnecessary in cases treated adequately with penicillin. Higgins et al.[14] aspirate the subperiosteal abscess and exhibit antibiotics.

The treatment of acute haematogenous osteomyelitis in these two hospitals is carried out traditionally by the general surgical staff. Our policy is based on the view that surgical decompression and drainage of the metaphysis are essential, the objects being (1) to evacuate pus, (2) to prevent sequestration by relief of tension, (3) to limit the amount of bone involved, and (4) to improve the blood supply and thereby the effectiveness of antibiotic therapy.

Tucker and Hollenberg[10] have confirmed what Agerholm and Trueta[8] had shown, viz. that massive doses of antibiotics cannot sterilize the metaphyseal abscesses. The penicillin controls and clears the septicaemia, but marrow cultures performed on metaphyseal abscesses after patients have been on massive doses of penicillin yield profuse growths of an organism, usually a staphylococcus aureus sensitive to penicillin, long after the blood cultures have been negative. What happens is that the patients survive and look well but that the osteomyelitis goes on to chronicity with recurrent flare-ups.

We treat our cases by drilling the lesions of the long bones in order to decompress them at the earliest possible moment; that is to say, after attention to fluid and electrolyte requirements, blood transfusion if necessary (and it is always necessary during the operation), and at least 12 - 24 hours of antibiotics, usually penicillin and streptomycin.* For osteomyelitis of the neck of the femur we drill the neck, through a lateral incision, with a hand-awl and with radiographic control, in much the same way as a guide-wire is inserted before putting in a trifin nail, but for the very opposite reason, viz. to see that the epiphyseal plate is not traversed.

Theoretically, there should be an early stage of the lesion when penicillin, alone and without decompression, should suffice. It is doubtful, however, whether such a stage ever exists by the time a diagnosis is made, or whether it could be differentiated from a state of affairs which does require decompression.

Every effort should be made to avoid bone sclerosis because of its detrimental effect on chemotherapy and its high yield of chronic osteitis.

Our cases, then, are drilled and are given antibiotics, these being changed if necessary upon receipt of the report on blood culture or pus-swab culture. The wounds are drained, and the patient's limb completely immobilized, usually in a plaster cast. On the 5th day the drain is removed under strictly aseptic conditions through a window cut in the plaster, and on the 10th day the sutures are similarly removed. Plasters are changed at regular intervals and radiographs taken at the same time. Weekly ESRs, white-cell counts and haemoglobin estimations are carried out, all being recorded on a special chart.

The temperature does not return to normal immediately but usually takes an average of 4 - 6 days to do so—the time actually varying between 1 day and 48 days. Immobilization and antibiotics are continued until clinically and radiologically

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* We have recently thought it advisable to commence treatment with penicillin and chlortetracycline instead of streptomycin.

there are no signs of activity and until 2 successive ESR estimations are below 20 mm. in the first hour. The duration of immobilization is reflected in Fig. 5. The patient is then allowed up, and is fitted with a weight-relieving caliper, which is discarded when successive radiographs indicate good calcification. The caliper does not always achieve its original purpose, but it does effectively limit the child's activity.
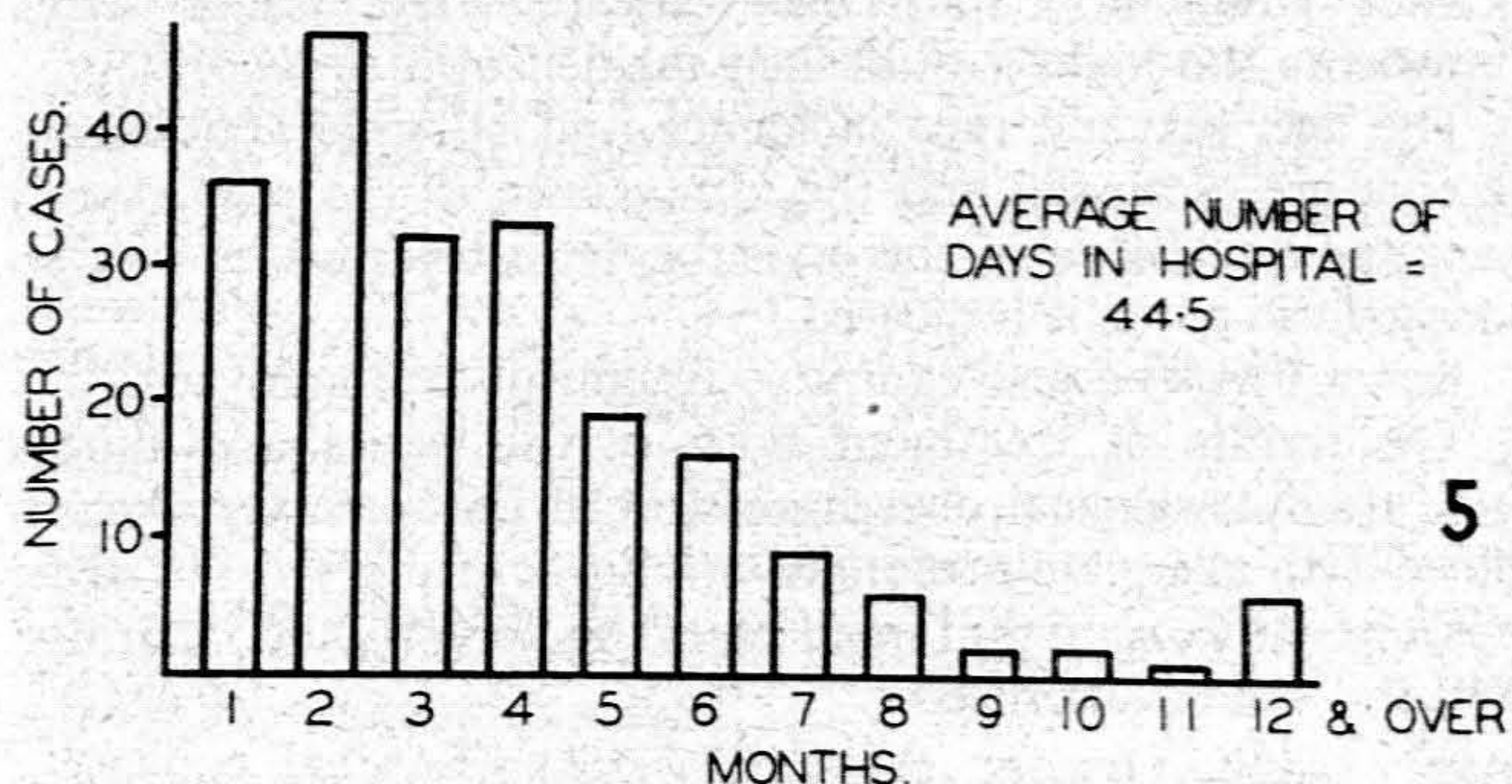

Fig. 5. Duration of immobilization.

At this stage active physiotherapy is begun in order to mobilize the joints and increase muscle power. The average stay in hospital is 44½ days.

Results

I have analysed the results in two main sections. The first (Table III) is the result as assessed from the case notes and

TABLE III. RESULTES OF TREATMENT

Nature of Treatment	No. of Cases	No. with Complications	Per-centage
Conservative non-operative treatment	30	10	33·3
Incision and drainage only	37	14	37·8
Incision and drilling of bone (medullary decompression)	202	24	11·8
Surgery without wound drainage	55	23	41·8
Surgery with wound drainage	186	35	18·8

Mortality following surgery—5 cases—1·7%

all relevant documents available; that is, without any follow-up. It will be seen that the method of treatment was by no means a uniform one. This is because these patients were treated by different surgeons; nowadays there is considerably more uniformity of management. I have indicated the nature of the treatment in some detail to assess the results with as much accuracy as possible. By complications I refer to anything including sequestrum, fracture, sinus, a second operation, wound sepsis, etc.

The results of conservative treatment, and of incision and drainage only, are very similar. It should be emphasized that, although the metaphyseal abscess has spread to the sub-periosteal region and while this is often described as the bone having decompressed itself, this is not the case. One has frequently drained such an abscess only to find that on drilling the bone pus escapes under considerable tension. The bone must be drilled, and in these cases the complications are only one-third of those in the previous two groups, where the bone is not drilled.

The presence of a drain in the wound likewise resulted in only one-half as many complications as in those cases in which the wound was not drained. This is not surprising; few surgeons drain an abscess and close it again at the same operation.

Five children died—a mortality of 1·7%. One died of malnutrition 4 months after the operation. The remaining 4 died within 17 days of admission of septicaemia, with pericarditis, pyelonephritis, and multiple pyaemic abscesses in lungs, myocardium, kidneys, liver, etc. Of these 4 patients, 3 were infected by a staphylococcus aureus sensitive to all the antibiotics, and one was infected by a similar organism sensitive to all the antibiotics except penicillin.

As regards follow-up: I managed to trace 109 of the 300 patients and the follow-up period ranged from 1 to 7 years, most cases being seen 3 years and more after their initial disease. Here the results have been recorded as good or bad (Table IV). By 'good' is meant patients who have had nothing in the way of symptoms or signs to indicate chronicity

TABLE IV. LATE RESULTS: 1-7 YEARS FOLLOW-UP

Nature of Treatment	No. of Cases	Results	
		Good	Bad
Conservative non-operative ..	6	4	2
Incision and drainage only ..	4	4	0
Incision and drilling of bone..	99	86	13
	109	94	15
		86·2%	13·8%

or activity. All had 100% normal function. All were radiographed and showed some sclerosis and periosteal reaction but no signs of activity or sequestra or rarefaction. Anybody, for whatsoever reason, not able to be classified as good, was called a bad result. It is clear that 86·2% of patients have done well.

It is interesting to compare our figures with those published elsewhere (Table V).

TABLE V. SUMMARY OF RESULTS IN OTHER SERIES

Author	No. of Cases	No. followed up	Good Results	Per-centage	Mortality
Butler,[15] 1940	500	253	127	50	2
White and Dennison,[17] 1952	212	78	60	76·9	1·2%
Trueta and Morgan[9] 1954	100	100	94	94	nil
Du Plessis,[16] 1953	33	16	16	100	6%
Tucker and Hollenberg,[10] 1948	19				
	10 drilled	10	10	100	nil
	9 conservative	9	4	44	
Bremner, Neligan and Warrick,[18] 1954	23				
	12 drilled	12	12	100	nil
	11 conservative	11	11	100	nil
			5 operated		
			3 not proved		
Altmeier and Largen,[19] 1952	110	110	79	71·8	nil
Caldwell and Wickstrom,[20] 1950	94	67 (75 lesions)	62	82·6	nil
Present series, 1959	300	109			1·7%
		6 conservative	4	66	
		4 drainage only	4	100	
		99 drilled	66	87	

Firstly—to indicate the appalling pre-war mortality and the disappointing results of treatment, which in very many cases included amputation,—there is the largest series ever

published—that of Butler[15] in 1940—500 cases collected, however, over a period of 18 years.

Trueta[9,10] has written frequently on this subject and, in his unit at the Wingfield-Morris Hospital in Oxford, achieves extremely good results.

Tucker and Hollenberg,[10] du Plessis,[16] and White and Dennison,[17] treat osteomyelitis on the lines I have outlined in this article.

Bremner, Neligan and Warrick[18] treated 2 small comparable series by the two methods available, viz. conservative and radical, and cured 100% of their cases in each group. But of the 11 cases treated conservatively, they admit that 5 were operated upon. Furthermore, on reading their paper critically, and also those of Altmeier and Largen[19] and Caldwell and Wickstrom,[20] who all rely on conservative antibiotic treatment with aspiration of subperiosteal abscesses if present, one must point out that the grounds for including many of their cases are slender. They include many cases where there are no radiological signs whatever and, as these cases are not operated upon, the presence of pus cannot be confirmed. In many cases, therefore, the grounds for diagnosis are suspect, and certainly osteomyelitis cannot be proved. One must as a consequence regard their figures as being very sanguine.

Now in the present series one or both of the following criteria had to be satisfied before any cases were included in the review: There had to be pus in the bone as found at operation and confirmed by culture, and/or definite radiological evidence of serial changes in the bone affected, consistent with the presence of a pyogenic infection.

It is clear, then, that the results of metaphyseal decompression are superior to those of conservative treatment and we feel fully justified in continuing our method of treatment.

We have come a long way since the days when this disease was highly fatal, and that in the main must be ascribed to the introduction of penicillin. However, there is no room for complacency and the clinician must constantly be alert to the possible presence of this disease. In 1928 Sir Harry Platt[21] said: 'Acute osteomyelitis must be given pride of place in the clinical consciousness of the practitioner....a small incision down to the metaphysis at the point of tenderness and puncture of the bone by means of a series of drill holes will save many limbs and many lives'.

Acute haematogenous osteomyelitis must still be regarded as a surgical emergency calling for extreme vigour in the management of its initial stage.

SUMMARY

300 cases of acute haematogenous osteomyelitis seen at the Red Cross War Memorial Children's Hospital and Groote Schuur Hospital, Cape Town, are reported. This series represents the highest published incidence in the world.

The age, sex and race incidence and possible aetiological factors are discussed and the importance of the regular and repeated estimation of the erythrocyte sedimentation rate as therapeutic guide is indicated.

Bones involved and causative organisms are analysed.

The results of treatment both in this series and others indicate that surgical decompression of the metaphysis combined with adequate prolonged antibiotic therapy is the treatment of choice, and that in all cases the bone should be drilled and the wound drained.

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