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**The Clinical Features and Surgical Treatment of  
Acute Septic Arthritis in Malawian Children**

**MD Thesis**

**University of London**

**2005**

**Christopher B D Lavy**

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MD Thesis, University of London, 2005

300 word abstract

Name: C B D Lavy

Discipline: Orthopaedic Surgery

Title: The Clinical Features and Surgical Treatment of Acute Septic Arthritis in Malawian Children

### Introduction

Untreated and poorly treated septic arthritis in children is a major cause of orthopaedic pathology in Malawi and the rest of sub Saharan Africa, yet little has been published on its early treatment, or its incidence, clinical features and bacteriology. This is the first prospective study to compare simple aspiration with surgical arthrotomy and lavage.

### Questions about septic arthritis the thesis will consider

- 1 What is the incidence?
- 2 What are the clinical features?
- 3 What is the bacteriology?
- 4 Is there a difference in outcome between treatment by aspiration and arthrotomy with lavage?

### Methodology

Two studies were performed. The first was an incidence study in a relatively closed population area. The second was a prospective study of 204 patients under the age of 16 with septic arthritis, randomised to treatment by aspiration (group 1) or arthrotomy and lavage (group 2), then followed up clinically, radiologically and haematologically for one year.

## Results

- 1 Septic arthritis has an annual incidence in Malawi of approximately 1 in 5000 for children under 5.
- 2 Children with septic arthritis are anaemic and underweight, with a mean haemoglobin concentration of less than 9g/dl, and a mean weight less than the 50<sup>th</sup> centile for their age.
- 3 The commonest joints involved are the knee and the shoulder, and there is a clear age spectrum for different joints, with shoulder sepsis having a mean age of 13 months, and hip sepsis a mean age of 7 years.
- 4 The predominant bacterial cause is *Salmonella*, especially in the upper limb.
- 5 Removal of pus by aspiration was not technically possible in 6% of patients, and even if successful needed repeating in 12%, whereas removal of pus by surgical arthrotomy was always successful.
- 6 Aspirated patients recovered faster and left hospital earlier, but apart from this early benefit there was no detectable difference in clinical, radiological or haematological outcome between aspiration and arthrotomy with lavage.

(298 words)

## Dedication

This thesis is dedicated to the following individuals:

Dr Ian Anderson, a missionary general practitioner, whose observations on the high prevalence of *Salmonella* in the joints of Zambian children first interested me in this subject.

Professor Liz Molyneux, whose work on septic arthritis challenged me to start this thesis, and whose dedication to the care of sick children continues to inspire many of us in Malawi.

Dr Nyengo Mkandawire, Malawi's only orthopaedic surgeon, a dependable colleague and torchbearer for children's orthopaedics in the country.

My wife Dr Vicky Lavy, who has suffered my frustrations but encouraged me enormously with this thesis, and all my work with children's surgery during our time together in Africa.

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## Chapter 1 Introduction

### 1.1 What is Septic Arthritis?

Septic or infective arthritis is a pathological condition of the synovial joints where bacterial infection affects the internal tissues of the joint. It is a very serious condition and if untreated can result in destruction of the articular surface of the joint. The infection can spread to the adjacent bones and lead to many complications including loss of the epiphysis, and osteomyelitis (6,7).

Septic arthritis is not common in developed countries, and the author saw very few cases in many years work in major orthopaedic units in the United Kingdom. On moving to Malawi however in 1996 the author has seen and treated many hundreds of cases.

In Malawi many cases arrive late, and by the time of presentation there are already severe complications, for example chronic suppurative sinuses (fig 1.1), rigid ankylosis (fig 1.2), dislocation (figs 1.3 & 1.4), and complete joint destruction (fig 1.5).



Fig 1.1 Septic arthritis of the right hip, with chronic suppurative sinuses.



Fig 1.2 Septic arthritis of the left elbow with rigid ankylosis



Fig 1.3 Septic arthritis of the right hip resulting in dislocation

Fig 1.5 Untreated Septic arthritis resulting in posterior dislocation of femoral head and shaft through buttock.



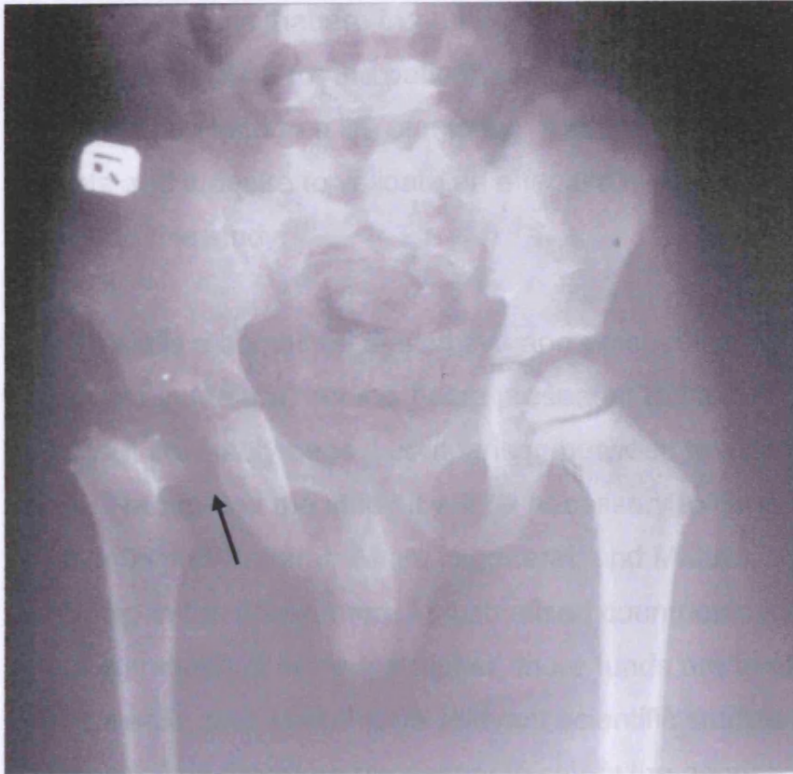


Fig 1.4 X ray of pelvis following septic arthritis of hip with complete destruction of the right femoral head (arrowed) compared to the normal appearance on the other side



Fig 1.5 Untreated Septic arthritis resulting in posterior dislocation of femoral head and shaft through buttock.

The complications that are illustrated above result in pain and severe limitation of function for the patient, and in a society where manual work is important, can lead to a life of misery. It is the author's concern for such patients and a desire to validate an effective method of early treatment that has led to this study.

This thesis is a combined descriptive and prospective scientific study conducted in Malawi, but it is being presented to the University of London. As such it inevitably begs a comparison between two distinct regions of the world. Throughout the study it will be necessary to compare the clinical situation in sub-Saharan Africa in general, and Malawi in particular, with that pertaining in the richer, more industrialised countries such as UK and USA, where standards of living are higher, more funds are available for treatment and research, and where more relevant scientific studies have been published. It is therefore necessary to clarify the geographico-social terminology that will be used. Many terms have been coined to describe those developed parts of the world where health services are relatively well financed. These include 'The West', 'The North', 'Developed Countries' and 'The Developed World'. Similarly many terms have been used to describe the poorer regions of the world. These include, 'The Third World', 'The Two-thirds World', 'The Developing World', and 'Developing Countries'. All such terms have their usefulness but also their shortcomings, and there is no terminology that is universally recognised in medical or scientific literature. In this study I shall aim to be geographic where possible and will use the words 'the West' to describe UK, Europe and USA, and 'sub-Saharan Africa' in its original sense to describe the region of Africa that is below the Sahara desert, and where septic arthritis in children is so common.

## 1.2 Background to Malawi and sub-Saharan Africa

Sub-Saharan Africa is the name given to the region of this continent that is below the Sahara desert. (fig 1.6) It is not a specific term nor does it have a clear political or economic definition, but it is however a useful term as it

contains several countries where there is severe poverty, and malnutrition, and in medical terms, where tropical and sub-tropical disease patterns can be found.

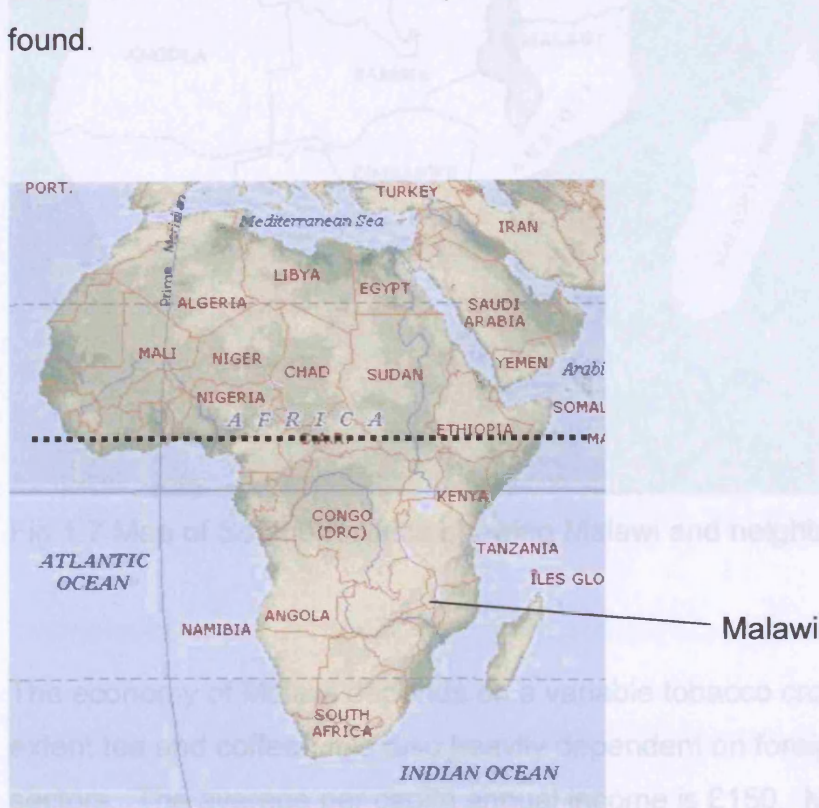


Fig 1.6 Map of Africa showing position of Malawi, and sub-Saharan region below thick dotted line

Malawi (figs 1.6 & 1.7) is in the heart of sub-Saharan Africa. It is landlocked, and compared to its neighbours a small country, but one that has a relatively large population of approximately 12 million. Malawi gained independence from Britain in 1964 and for the first thirty years had a one party government under the self proclaimed 'president for life' Dr Hastings Kamuzu Banda. In 1994 he stood down to allow a multiparty democratic system of government.



Fig 1.7 Map of Southern Africa showing Malawi and neighbouring countries

### *Salmonella Septic Arthritis of the shoulder in Zambian Children*

The economy of Malawi depends on a variable tobacco crop and to a lesser extent tea and coffee. It is also heavily dependent on foreign aid in all sectors. The average per capita annual income is £150. Most of the population are subsistence farmers, growing their own food. The main staple diet is maize which has a single growing season, thus if the annual crop is poor, there is inevitable malnutrition and starvation.

*During the course of this study several parts have been presented and*

Malawi has a government health system, which is free at the point of delivery, but is overwhelmed by need and thus struggling to deliver even basic health care to all. A significant number of Malawian doctors have been trained over the years since independence but most of these practise in richer countries. In 1991 a medical school was opened and is now producing 25 graduates per year. There is hope that many of these doctors will stay on in the country to help develop the medical services. At the time this study was started the author was the only orthopaedic surgeon in the country. At the time of writing there are now four, three from UK, and one Malawian who trained in UK. There are also four orthopaedic trainees.

*Hunterian Professorship and Hunterian Orator to the Royal College of Surgeons of England given at the British Orthopaedic Association annual meeting in Birmingham September 2001*

### 1.3 What is known about septic arthritis in sub-Saharan Africa?

#### 1.3.1 Previous work by this author

The author's interest in septic arthritis started in 1992 when as a young surgeon he worked for a year in a rural hospital in northwest Zambia. Two studies of septic arthritis were published and are referenced below. Where relevant they will be referred to in the literature review that follows.

##### **Salmonella Septic Arthritis in Zambian Children.**

Lavy C B D, Lavy V R, Anderson I.

Tropical Doctor (Royal Society of Medicine) 1995; 25: 163-166.

##### **Salmonella Septic Arthritis of the shoulder in Zambian Children.**

Lavy C B D, Lavy V R, Anderson I.

Journal of The Royal College of Surgeons of Edinburgh. 1996; 41: 196-199.

#### 1.3.2 Published & presented work from this study

During the course of this study several parts have been presented and published. These include the following:

##### **100 Cases of Septic Arthritis in Children**

Lavy CBD, Thyoka M, Mannion SJ

Paper presented at joint Japanese Orthopaedic Association / British Orthopaedic Association Annual meeting London October 2000

##### **Septic Arthritis in sub-Saharan Africa**

Lavy CBD

Hunterian Professorship and Hunterian Oration to the Royal College of Surgeons of England given at the British Orthopaedic Association annual meeting in Birmingham September 2001

**The Blantyre Septic Joint Score: a new scoring system for septic arthritis**

Smith SP, Thyoka M, Lavy CBD, Pitani AD

Tropical Doctor (Royal Society of Medicine) 2002; 32:250-251.

**Septic Arthritis of the shoulder in children in Malawi. A randomized prospective study of aspiration versus arthrotomy and washout.**

Smith SP, Thyoka M, Lavy CBD, Pitani AD

Journal of Bone and Joint Surgery Br 2002; 84(8):1167-72

**The Bacteriology and Clinical Features of 200 cases of Septic Arthritis in Malawi**

Lavy C B D, Thyoka M

Journal of Bone and Joint Surgery Br. (in press, accepted June 2005)

**The incidence of Septic Arthritis in Malawi**

Lavy CBD, Peek A, Manjolo G

International Orthopaedics (in press – accepted May 2005)

**Does Long Term Chloramphenicol for Musculoskeletal Infections in Children cause Anaemia?**

Peek A, Lavy CBD

Tropical Doctor (Royal Society of Medicine) (in press – accepted April 2005)

Mr Smith, Dr Thyoka, and Dr Peek in the papers above were the author's registrars and assisted in the follow up clinics with the study patients. The author however remained principal investigator.

In addition to the published and presented papers above the following papers have been prepared from the material in this thesis and have been submitted for publication:

**A Literature Review of Paediatric Septic Arthritis**

Lavy CBD

## **Aspiration or Arthrotomy and Lavage as Initial Treatment of Septic Arthritis**

Lavy CBD

## **How long should Antibiotics be used in Septic Arthritis?**

Lavy CBD

### **1.3.3 Literature review on septic arthritis with relevance to sub-Saharan Africa**

#### **1.3.3.1 Incidence**

Septic arthritis in children is rare in the West and common in sub-Saharan Africa. There is little more detail on incidence or prevalence than this in the published literature. In 1990 Shaw (106), in a review of septic arthritis in infancy and childhood reported that it is approximately twice as common as osteomyelitis in this age group, but that its relative incidence decreases, so that by adolescence the two conditions occur with a similar incidence. There are several reported studies of septic arthritis from the West and from sub-Saharan Africa (56, 65, 66, 79, 86) which again suggest that it is much more common in Africa. These reports all discuss cases that presented at single institutions and none of them has a denominator or source population so that no accurate estimate of incidence can be made.

#### **1.3.3.2 Aetiology and Pathogenesis**

A few cases of septic arthritis occur because of direct inoculation of bacteria into the joint, through injury, or snake or animal bites in a rural community, or by iatrogenic causes such as hip infection following femoral artery puncture (84), but the majority of cases are believed to occur by internal dissemination of bacteria (77, 95). The bacteria may arrive in the joint via the blood stream, as haematogenous spread, or by direct spread from adjacent structures. In

the hip and the shoulder, part of the metaphyseal shaft is intra-articular, and osteomyelitis of the femoral or humeral shaft may spread to the adjacent joint (85). Trueta (119), in 1959 showed that neonates have small transphyseal blood vessels which allow direct spread from the bone to the epiphysis and thus to the joint. These vessels disappear at around 6 months. This may explain the different pattern of clinical appearance of septic arthritis between neonates and older infants. With the former it is more common to have an associated osteomyelitis, indeed in some series 60-100% of cases of neonatal septic arthritis have adjacent osteomyelitis (106).

The presence of bacteria in a synovial joint either by direct or haematogenous spread does not necessarily cause septic arthritis. Many children have a severe persistent bacteraemia but do not develop septic arthritis (40). It is likely that there is a combination of other factors involved, in addition to the presence of bacteria. It is also very likely that trauma is one of these factors. In many cases of septic arthritis there is evidence of preceding trauma, and it is a plausible theory that capillary stasis as a result of this trauma causes a nidus of infection that may develop into septic arthritis. Microtrauma at the capillary level may also reduce oxygen tension locally and decrease the efficiency of the natural humoral and cellular defence response (95). The joints of the lower limb in the West are more commonly involved in trauma than the upper limb and have correspondingly more septic arthritis. Olney's work on rabbits (92) supports this theory, that microtrauma in the presence of a co-existing bacteraemia renders joints susceptible to infection.

When a blood-borne pathogenic bacteria arrives at a susceptible synovial joint a cascade of events is set in motion. The synovium is extremely vascular and contains no basement membrane, with the result that bacteria and white cells leak into the joint space (106). Polymorphonuclear leucocytes are activated by the presence of bacteria and produce both collagenase and neutral and acid proteases (20, 21). The white cells are not the only source of destructive enzymes, as the synovial lining cells also produce enzymes (29), as do some bacteria, especially *Escherichia coli* and *Staphylococcus aureus* (112). These proteolytic enzymes destroy the mucopolysaccharide



ground substance of articular cartilage and allow collagen fibres in the cartilage to be further destroyed by friction as the joint moves. William Hunter had no knowledge of the existence of enzymes but gave an apt description three hundred years ago when he noted in 1743 the destructive effects of sepsis on articular cartilage, stating:

*“When a cartilage is inflamed and soaked in a purulent material, the connecting fibres will be the soonest to give way and the cartilage will become soft and red”.* (53)

Today we know a little more about the mechanism, but the basic pathological description remains valid. Phemister in 1924 was an early worker in the field of joint infection and found that incubation of cartilage with *Staphylococcus aureus* alone did not result in any cartilage breakdown, but the addition of staphylococcal pus to the ferment caused destruction of the cartilage (99).

Smith (108) showed that cartilage destruction starts to occur as early as eight hours after infection. Early administration of antibiotics helps to slow down the process but even if intravenous antibiotic therapy is started within the first 24 hours of infection, significant glycosaminoglycan destruction and collagen disruption occurs. Potent inhibitors of these proteolytic enzymes have been found in joint fluid so it is likely that there is a complex interplay of enzymes within the joint (42.)

In addition to enzymes from bacteria, white cells and synovium, the chondrocytes themselves may also play a part in the destruction of cartilage. Ultrastructural analysis of chondrocytes in experimentally produced septic arthritis has shown an increase in lysosomal electron dense bodies, suggestive of production of proteolytic enzymes in both superficial and deep layers of articular cartilage. Chondrocytes, in common with polymorphonuclear leukocytes have both neutral and acid proteases and may be stimulated to release these either by bacterial lipopolysaccharides, or by interleukin 1 (IL-1) (38, 57, 78).

The source of IL-1 is generally thought to be the monocyte (46). IL-1 acts as an inflammatory hormone rather than having any intrinsic enzymic or degrading activity itself. It can lead to increased amounts of prostaglandin E and collagenase from both the chondrocyte and synovial cells. In mature cartilage without sepsis, chondrocytes respond to IL-1 by breaking down the surrounding proteoglycan matrix.

Recent work on joint destruction in septic arthritis suggests that in addition to the acute inflammatory mechanism above, there is also a delayed immune response that does not require viable bacteria. Arthritis can be induced experimentally in animals by systemic injection of bacterial antigens, such as peptidoglycans (41, 60). These antigens are preferentially deposited in the synovial tissue of remote joints and incite a sustained immune response resulting in arthritis. Laboratory work with mice shows that strains of *Staphylococcus* that produce exoproteins, (ie enterotoxin) cause more severe arthritis in infected joints than do strains that do not produce exoproteins (3). Following on from this, it was discovered that specific inhibition of T-lymphocyte proliferation decreases the severity of arthritis, while generalized inhibition of the immune system increases the severity of arthritis (1, 2). This leads to the possibility that bacterial antigens and bacterial exotoxins stimulate T-lymphocyte proliferation, and that this can occur even though the bacteria have been killed. T lymphocytes then degrade ground substance and destroy articular cartilage, thus playing a similar role in infective arthritis to the role they play in non-infective chronic arthritis (12).

### 1.3.3.3 Predisposing causes

Joint infection is perhaps surprisingly uncommon in HIV positive adults, but where it is found it is often associated with intravenous drug abuse, haemophilia and a CD4 count in the region of 250 (120). Children who are HIV positive have an increased risk of septic arthritis (51), and anaemic, malnourished, underweight children in sub-Saharan Africa are also at high risk (65, 66, 79). In adults, *Salmonella* septic arthritis is associated with

systemic lupus erythematosus (SLE), liver disease, schistosomiasis, and avascular necrosis (17). It has also been reported after iguana bites (91). Salmonellosis, osteomyelitis and joint infections are also common in sickle cell disease (5). The cause for this is probably the fact that intravascular sickling causes capillary occlusion, which devitalizes and possibly infarcts the gut, permitting salmonella invasion. Reduced function of the liver and spleen together with interference of reticuloendothelial system function due to erythrophagocytosis also suppresses clearance of *Salmonella* from the blood stream. Abnormal opsonisation and complement function probably also plays a role (5).

#### 1.3.3.4 Clinical Features

A child with acute septic arthritis is typically unwell, with a fever. The joint is usually swollen, warm to the touch, and acutely painful. The pain is exacerbated by movement and the child holds the limb still. The position of most comfort varies with the joint, thus the septic hip is held in slight flexion, external rotation and abduction, the knee in slight flexion and the shoulder in internal rotation and abduction. These positions represent the position of maximum joint volume and therefore minimum pressure. If the condition is not treated then the infection may spread to cause local cellulitis and swelling of the whole limb. The child may also become toxic. Having outlined the typical case however, the infant and neonate with a less well developed immune system may present with much less severe symptoms and signs. The clinician must be alert to the possibility of septic arthritis in an infant with a swollen joint, minimal pain and no or mild fever (106). In the author's Zambian series several of the children presented with so called 'pseudoparalysis' (66). The affected limb was floppy and not actively used. If it was examined there did not appear to be significant pain. There are no comparative figures on the prevalence of pseudoparalysis in Western and sub-Saharan children with septic arthritis but it is the observation of many clinicians that it is relatively more common in Africa. This may be due to the poor nutritional state of patients in sub-Saharan Africa, and to the reduction in immune response (25).



Fig 1.8 Child with untreated septic arthritis of the left knee showing the classical clinical features of pain and swelling.

### 1.3.3.5 Joints involved

There is a major difference in terms of the site of infection between septic arthritis in children in the West and children from sub-Saharan Africa. The main reason for this is the large number of infections of the shoulder that are seen in sub-Saharan Africa. Jackson and Nelson reviewed 514 infected joints in 471 Western children and found the knee to be the most commonly affected with 41%, followed by the hip with 23%, the ankle with 14%, the elbow 12%, and the wrist and shoulder 4% each (56). In Gillespie's series of 102 children the shoulder only represented 3% (33). Molyneux's series from Malawi in 1982 reported the shoulder as being involved in 28% of cases, second only to the knee with 51% (79). In the author's own series from Zambia the shoulder was involved in 19 out of the 34 prospectively studied cases, representing 56% of all infected joints (66). Molyneux is the only

author to have proposed a mechanism to explain why the shoulder is so commonly involved. She has observed that mothers in sub-Saharan Africa carry their children on their backs and swing them up by the arm. She has postulated the theory that microtrauma to the joint may make it susceptible to seeding of infection when there is a bacteraemia (79).

Boys are more commonly affected by septic arthritis than girls (65,33,87). There is no obvious reason for this gender difference, but it may be that boys are more likely to be involved in activities that lead to repetitive minor joint trauma (109).

#### 1.3.3.6 Complications

Untreated septic arthritis can cause cartilage destruction by the mechanisms outlined in 1.3.3.2 above. Infection can then spread to the underlying growth plate, causing destruction of the physis with consequent loss of growth, or tethering of the plate causing deformity (96). Epiphyseal separation can also occur (7, 76). Joint infection can also spread to the adjacent bone and cause osteomyelitis (6). The presence of infection in the joint can cause a reactive capsular thickening which may reduce movement and result in fibrous ankylosis and even joint fusion. It may also lead to the opposite, namely capsular stretching and joint laxity or dislocation. Longstanding joint sepsis can discharge to the outside and cause chronic sinus formation and subsequent superinfection (6).

#### 1.3.3.7 Bacteriology

In the West, septic arthritis may be caused by a wide spectrum of bacteria but there is a definite age relation to the common pattern (77). In neonates less than two months old infected in the community the common organisms are group B *Streptococci*, followed by *Staphylococcus aureus* and gram negative rods. If the infection was acquired in the hospital situation then

*Staphylococcus* is more common and is reported as being the cause in up to 62% of cases (22). In the infant from two months to four years in the West *Haemophilus influenzae* has in the past been reported to be the commonest cause of septic arthritis (106), however with increasing and effective vaccination campaigns the influence of this bacteria is diminishing (11, 50) and *Staphylococcus* and *Streptococcus* are again the common causes (77). Some authors also report an increase in incidence of joint infection by *Kingella kingae* which mirrors the decline of *H. influenzae* (63, 64).

#### 1.3.3.7.1 High prevalence of *Salmonella* infections in sub Saharan Africa

The picture is completely different in sub Saharan Africa where *Salmonella* has a very high prevalence. It was cultured in 26 out of 34 (59%) of the author's cases in Zambia (66). All of these children were under three years of age. *Salmonella* was grown in 40% of the culture positive cases in Molyneux's Malawi series (79), and 60% of the cultures in Ndauti's series in Kenya (86).

The reason for the high prevalence of *Salmonella* in septic arthritis is probably because it is the single most prevalent organism found in the blood of sub-Saharan children (69, 73, 89, 122). Most cases of *Salmonella* bacteraemia are found in children between six months and five years of age with the highest incidence between the ages of ten and fourteen months (39, 40), It is also strongly associated with anaemia, poor nutritional status, and malaria (39, 40, 69, 73, 89, 122). In the author's Zambian series all the 26 children with *Salmonella* septic arthritis were anaemic and all were underweight (66). It is thus likely that the high incidence of *Salmonella* septic arthritis is secondary to the high prevalence of *Salmonella* bacteraemia, which is in turn secondary to the poor nutritional status of the children in this part of Africa. The argument is strong if not compelling that *Salmonella* septic arthritis in sub-Saharan children is a disease of poverty.

### 1.3.3.8 Diagnosis

The diagnosis of septic arthritis is essentially clinical. It has already been discussed above that in young children, and especially malnourished children there can be a less acute clinical presentation and diagnosis is harder. In well nourished children with a normal immune response there is typically an elevated ESR and white cell count, but, as with the clinical appearance, in the anaemic underweight child these parameters may be normal. The author's Zambian series had many cases where the ESR and neutrophil count were normal (66). Where C reactive protein (CRP) can be measured it has been reported as being more sensitive in both diagnosis and monitoring (121).

The definitive diagnostic test is bacteriological examination of the joint fluid collected by aseptic needle aspiration of the affected joint. This should be performed with a wide bore needle, (at least 20 gauge) to ensure adequate aspiration. The fluid should be Gram stained, cultured, and white cells, glucose and lactate should be measured. The gram stain alone may confirm the diagnosis in up to 50% of cases (80). It can also give guidance for early antibiotic selection before culture and sensitivity results are available. Some series report positive culture rates of as low as 60% (86), however other reports have positive culture rates of 80% (47). Ike (54) suggests that increased efficiency of joint fluid culture can be obtained by immediate transfer of the joint aspirate to blood culture bottles. The synovial fluid white cell count in septic arthritis is variable ranging from 25,000 to 250,000 cells per millilitre, however the differential consistently reveals around 90% polymorphonucleocytes (37, 48, 61, 84). Synovial fluid glucose levels in septic arthritis decrease relative to serum glucose levels and are often below 40mg per decilitre (37). Comparisons between serum and joint glucose levels are often made harder because of time differences in sample taking, and intravenous infusions in seriously ill patients which may alter serum levels. Lactic acid levels in synovial fluid may be elevated, except in gonococcal infections (114). Immunoelectrophoresis may be performed to look for antigens to *Haemophilus*, *Meningococcus*, *Strep. pneumoniae* and other bacteria (114). PCR (Polymerase chain reaction) assay, where it is available,

may also be used to detect remnants of bacteria in the face of negative culture (54).

Imaging of infected joints is not easy. Plain X rays often show no bony changes in the first 10 days of an infection. There may however be evidence of a widened joint space relative to the uninvolved side (106). This increased space, and the fluid that is causing it can also be demonstrated with ultrasound scans. Radioisotope scanning using technetium, or gallium or indium labeled white cell scans may be performed but are not generally very helpful in diagnosis as they can be positive in both septic arthritis and adjacent osteomyelitis. (9, 47, 117). Some authors however are more optimistic about their usefulness (6). Computerised tomography (CT) and magnetic resonance imaging (MRI) scans are seldom used in the diagnosis of septic arthritis, but if available can show the presence of fluid in the joint, and early changes in the adjacent bone. They may also show reactive changes or spread of infection to the surrounding tissues. MRI can also differentiate between septic arthritis and transient synovitis (68).

#### 1.3.3.9 Differential Diagnosis

This includes chronic infections such as tuberculosis and fungal infections, trauma, juvenile chronic arthritis, and other non infective arthropathies, rheumatic fever, adjacent osteomyelitis, sickle cell disease, haemophilia, neoplasia, and Henoch Schonlein Purpura (106). Mechanical problems also need to be considered, including Perthe's disease and slipped femoral epiphysis in the hip, and cartilage problems or other causes of internal derangement in the knee.

#### 1.3.3.10 Treatment

The above review of literature shows that septic arthritis involves an inflamed joint that contains bacteria and pus. On purely empirical grounds it has long



been felt that the treatment should involve removal of the pus as rapidly and as completely as possible, and that this should be combined with the administration of antibiotics. Few authors would disagree with that outline. However the method of draining the pus remains a matter of considerable debate (49). The general principle of removing pus from an infected joint is not questioned, and is usually assumed to be self evident, although as with many established ideas in medicine, there is no prospective study evidence that removal of the pus gives a better outcome than leaving it in the joint. As with many long established ideas in medicine, it is now difficult to question and it would be hard to get ethical permission to conduct a study that compared removing pus to leaving it in the joint.

There are a number of possible ways of removing the pus, ranging from invasive surgery where the joint is formally opened, via minimally invasive surgery such as arthroscopy (8), so called tidal irrigation (55), where the joint is aspirated then saline or other lavage fluid is washed in and out of the joint through wide bore needles, to simple aspiration. There has never been a prospective comparison of all the above methods of removing pus, or even a prospective comparison between any of them. Different authors tend to favour their chosen method. Goldenburg (35), and Lane (63), have both observed that the method of pus removal offered to a patient with septic arthritis depends largely on the specialty of clinician under whom the patient is admitted. Patients being looked after by paediatricians and rheumatologists tend to have needle aspiration, while patients looked after by surgeons have a surgical method of pus removal. Advocates of their own methods make claims for their particular technique, for example Parisien (94) claims that arthroscopy "is the most reasonable alternative to repeated aspirations or arthrotomy in the management of pyarthrosis in accessible joints". Chung (18) also advocates arthroscopy and gives examples of successful treatment but offers no control group.

Other authors have written case reports of successful treatment by one or other of the methods of pus removal (31). Goldenburg in 1975 tried to throw light on the controversy and wrote a retrospective review comparing needle

aspiration to surgery as modes of initial drainage (35). Broy in 1986 returned to the same question and reviewed the literature from 1959 to 1984 to find the answer (15). Neither paper was conclusive. In 1993 Ho entitled his editorial "How best to drain an infected joint. Will we ever know for certain?" (49). Three years previously Shaw in a major review of acute septic arthritis (106) described open surgical drainage as the "gold standard" for removal of pus, against which all other methods are measured. Bertone in a study on septic arthritis in horses showed that arthrotomy eradicated joint infection more completely than arthroscopy, but that secondary wound infection was a problem (8). Nord, in a study on septic arthritis in goats showed that giving antibiotics with arthrotomy, or arthroscopy, or needle aspiration or even just giving antibiotics on their own gave similar results (90). These last two studies are interesting attempts to solve the problem, but they involve an animal model and it is questionable as to whether their results hold for humans.

Some authors have concluded that aspiration is a satisfactory method for all joints except the hip, and others that the hip joint can be satisfactorily aspirated (123). Many take the midline view that they will start with joint aspiration and if it fails then move on to surgery (48). It is hard to escape the observation that there is as yet no clear answer to this question.

How antibiotics are administered and for how long are two more questions for which there are no definitive studies. Most clinicians agree that intravenous antibiotics are advised in the early stages, with a change to oral when the patient is afebrile. Many clinicians also give antibiotics for 4 to 6 weeks, but again there is no scientific backing for this period. There is animal evidence that steroids administered with antibiotics may have a protective effect in reducing cartilage damage (115)

After the pus has been removed and antibiotics have been given, most clinicians will allow the patient to move the joint as the pain allows. One of the fathers of British orthopaedics, Robert Jones, had a dictum that rest after infection of a joint should be "prolonged, uninterrupted and enforced" (104). This has gradually been discarded as Salter in a seminal study on rabbits in

1981 showed that continuous passive motion gave improved clinical and pathological results after joint infection and injury (104). The study has not been repeated in humans, but early movement has become accepted practice. It will probably never be tested because of the difficulty of restraining people, especially children, who want to move, and because of the many other advantages of being active.

#### 1.3.3.11 Prognosis

Septic arthritis is a serious condition in any part of the world. The potential for major complications makes its diagnosis and early treatment an emergency. There is no doubt that the major factor in the improved management of septic arthritis in the last century was the discovery of antibiotics. In 1920 the mortality for a child with septic arthritis was around 10% and this was reduced to less than 1% by 1970 (33). There have been no prospective studies looking specifically for prognostic factors in septic arthritis, nevertheless certain factors have regularly been associated with poor outcome. These are as follows:

- Age less than one year (49), which is probably due to immaturity of the immune system.
- Joint site, especially the hip and the shoulder, and polyarticular infections (24). The shoulder and the hip both have an epiphysis that is completely contained within the joint, and perhaps more vulnerable to infection and vascular embarrassment, and they both have intra-articular metaphyseal bone. Thus spread of infection from adjacent osteomyelitis is possible. The presence of infection in more than one joint may indicate a reduced host response to infection, which is itself likely to be linked to a worse prognosis.

- Underlying serious illness eg renal failure, diabetes, cirrhosis and malignancy (49). A poor outcome in this group is likely to be due to the combination of chronic disease and acute infection.
- Immunosuppressive drugs eg corticosteroids and cytotoxic agents (24). This is only to be expected as the drugs reduce the body's ability to resist infection.
- Long duration of symptoms and long delay in treatment (83, 108). If the degree of damage to the joint by bacterial and other enzymes is related to the length of time these enzymes are in action, then delay in treatment is likely to be detrimental to outcome.
- Virulent organisms especially *Staphylococcus aureus* and gram negative bacilli (34). This may be due to associated cell mediated immunity caused by bacterial exoprotein.

The above factors are taken from literature relating to patients from the West, but are likely to be of relevance also to prognosis in septic arthritis in sub-Saharan Africa.

## 1.4 Questions to be answered by this thesis

Having reviewed published literature on septic arthritis in the sub-Saharan African region it is clear that there is a need for more detailed descriptive study of the incidence, bacteriology and clinical features of septic arthritis in this part of the world where it is so common. There is also a need to review the unanswered question as to what is the best initial surgical intervention in septic arthritis, simple aspiration, or open arthrotomy and lavage. There is no consensus in the literature that was reviewed in 1.3.3.10. This thesis therefore aims to answer four main questions which are listed below. The detailed methodology of the thesis will be addressed in chapter 2 but the questions to be answered will be outlined here.

The first question, namely:

### **1.4.1 What is the incidence of septic arthritis in children in Malawi?**

involves counting cases that present in a known time period in a known population and will be addressed in a separate descriptive study in a population of known size, in order to determine both the numerator and the denominator values and thus calculate the incidence.

The second and third questions concern pathogenesis and clinical features:

### **1.4.2 What is the clinical presentation of septic arthritis in children in Malawi?**

### **1.4.3 What is the bacteriology of septic arthritis in children in Malawi?**

These will be answered by a careful prospective descriptive study. The fourth question:

### **1.4.4 Is there any difference in outcome between simple needle aspiration, and formal surgical arthrotomy with lavage, in the treatment of septic joints in children in Malawi?**

is the main question in the thesis and is a much harder question to answer. It will be investigated using a prospective randomised controlled study, testing the null hypothesis that there is no difference in outcome between the two treatment methods. The answer to the fourth question will have more than just academic relevance, as in Malawi open surgery is expensive and not always available. Some hospitals have no anaesthesia, and theatres of dubious cleanliness. It is therefore of great practical importance to know whether aspiration and antibiotics are adequate to treat septic arthritis in these hospitals, or whether all cases should be referred to hospitals where there is a surgeon and a functioning theatre.

## Chapter 2 – Methodology

### 2.1 Introduction

This chapter describes 2 distinct and concurrent studies. The first is an incidence study and is described in 2.2. It was performed in Chikwawa district, a neighbouring district to Blantyre, and was a separate study performed purely to answer the first question of this thesis, namely:

- What is the incidence of septic arthritis in children in Malawi?

The second, described in 2.3, is the main study, and addresses the other three questions asked by this thesis, namely:

- What is the clinical presentation of septic arthritis in children in Malawi?
- What is the bacteriology of septic arthritis in children in Malawi?
- Is there any difference in outcome between simple needle aspiration, and formal surgical arthrotomy with lavage, in the treatment of septic joints in children in Malawi?

### 2.2 Incidence Study

The main study for this thesis was performed at the Queen Elizabeth Central Hospital (QECH), Blantyre, which is the biggest hospital in Malawi and the home of the new College of Medicine which started in 1991. As a large referral hospital QECH draws its patients from many parts of the country and cannot reasonably be said to serve a particular district, nor does it have a denominator population. For this reason it would have been difficult to estimate an incidence for septic arthritis by counting the number of patients who attended QECH with septic arthritis in any given period.

35 km south of Blantyre is a small district called Chikwawa with its own busy district hospital. The residents of this district do not travel far as they are bounded by the river Shire and the western slopes of the Great African Rift Valley on one side, and by the border with Mozambique on the other. Thus the people who attend the district hospital are mainly local inhabitants of the district. This district was therefore chosen as the site for an incidence study.

### 2.2.1 Patients and methods

The population of Chikwawa as estimated by the Malawi National Statistical Office for 2001 (124) is 412,800, with the population between 5 and 16 years estimated at 131,000, and under 5 years at 71,000. Between 1<sup>st</sup> July 2001 and 30<sup>th</sup> June 2002 all patients aged 16 and under with a clinical diagnosis of septic arthritis that attended Chikwawa district hospital were recorded. The recording was performed by a trained orthopaedic clinical officer who examined all the cases, He confirmed the diagnosis clinically by drainage under aseptic conditions, and further treated the patients with antibiotics.

## 2.3 **Main study – Bacteriology and clinical features of septic arthritis, and its treatment by aspiration versus arthrotomy and lavage**

### 2.3.1 Aim of Study

The aim of the study was to record prospectively the clinical, haematological and bacteriological features of all cases of septic arthritis in children under 16, and also to undertake a prospective comparison of treatment by aspiration and antibiotics (group 1), versus arthrotomy with lavage and antibiotics (group 2).



### 2.3.2 Location of study

The site for this study was Queen Elizabeth Central Hospital in Blantyre (QECH). It is the major referral centre for the South of Malawi and at the time of the study was the only hospital in Malawi with an orthopaedic surgeon.

Operating theatre facilities at QECH are limited and for the purposes of this study a separate operating theatre was set up and staffed with nurses and an anaesthetist whose first priority was the study. The author received the Sir Ratanje Dalal scholarship from the Royal College of Surgeons of England for his work on septic arthritis, and the main use of the scholarship funds was setting up this theatre. The theatre and nursing staff were available to the study for 24 hours a day, but when not being used for the study the theatre was available for other orthopaedic surgery.

Patients were admitted to the paediatric wards of QECH and the follow up clinics were conducted in the paediatric department.



Fig 2.1 Theatre established and equipped for this study

All children in the study had a full clinical examination including height and weight measurements and a Blantyre Septic Joint Score (BSJS) (see table 2.1). This is a scoring system devised by the author specifically for this study and independently verified and published (110). The Blantyre Septic Joint Score was created as there was a need to have an objective scoring system

#### 2.3.4 Recruitment to study

All children under the age of 16 who presented to QECH with a clinical diagnosis of an acute septic joint, namely an acutely swollen joint, no history of significant trauma, and no previous antibiotic or surgical treatment, were eligible to enter the study. Ethical permission for the study was obtained from the Malawi College of Medicine's Ethical and Research committee. (See copy of permission in Appendix 1, page 137). The author and his registrar were available 24 hours a day to see cases. The study was explained to the mother or guardian and written consent obtained. (see Appendix 2, page 140, for copies of consent form in English and Chichewa – the local language). If patients or guardians were not willing to take part in the study they were still offered care, and the extra facilities funded by the study including the theatre and any needed antibiotics were available to them.

In order to determine the number of children needed in each group, a power calculation was performed. For the purposes of this calculation the normal improvement rate (defined as a return to normal pain free function) for septic arthritis following treatment was estimated at 70%. In order to determine with 95% confidence and a power of 90%, a 20% difference in improvement a group size of 92 was needed. Epi-info version 6 was used for this calculation. Thus allowing for a 10% loss to follow up, it was decided to recruit approximately 100 children into each group, and to continue recruitment into the study until 200 had been reached. It was estimated before the study that to recruit this number of patients would take approximately one year.

#### 2.3.5 Examination and Investigations

All children in the study had a full clinical examination including height and weight measurements and a Blantyre Septic Joint Score (BSJS) (see table 2.1). This is a scoring system devised by the author specifically for this study and independently verified and published (110). The Blantyre Septic Joint Score was created as there was a need to have an objective scoring system

for septic joints that would allow measurement of whether the joint was improving or deteriorating clinically. Most of the published literature on septic arthritis agrees that the four common and classic physical signs are swelling, tenderness, decreased range of motion and loss of function. A range of 1-4 points for each of the above four parameters was allocated as shown in the table below. The scores for each parameter are added together to give the total joint score, which varies from 4 (worst possible) to 16 (normal).

Table 2.1 outline of Blantyre Septic Joint Score

Parameter	Grade	Score	Explanation
-----------	-------	-------	-------------

SWELLING	Gross	1	Gross swelling
	Moderate	2	Clear swelling, obvious without comparison to the other side
	Minimum	3	Just perceptible swelling (usually needs comparison with the other side to detect it)
	None	4	Normal joint

TENDERNESS	Marked	1	Severely tender, cannot tolerate palpation
	Moderate	2	Obvious tenderness but tolerates palpation
	Minimum	3	Slightly more tender than the other side
	None	4	Normal joint

RANGE OF MOVEMENT	None	1	None or virtually no movement (less than 10% normal range)
	Minimal	2	Some movement (11- 50%)
	Moderate	3	A reasonable range but not full (51% - 90%)
	Full	4	Normal range of movement

FUNCTION	None	1	No function in activities involving the joint
	Minimal	2	A little function but severe restriction of activity involving the joint
	Moderate	3	Fairly good function but not normal
	Full	4	Normal

In addition to a clinical examination the patients then had the following blood tests performed:

Table 2.2 Blood tests performed

Test	Method	Notes
Haemoglobin estimation	Beckman Coulter Counter	
White Cell Count and differential	Beckman Coulter Counter	
Erythrocyte Sedimentation Rate	Suction pipette and Westergren tube	
Sickle Cell Test	Standard sodium metabisulphate test.	
HIV test	Determine and Unigold standard test kits	Pre and post counselling were offered. (where the child was less than 1 year old HIV testing of the mother was also done).

Table 2.2 Blood tests performed (continued)

Test	Method
Blood Cultures	A maximum blood volume of 2mls was added to a single blood culture bottle (20mls Brain Heart Infusion Broth containing sodium polyanethol sulphonate, E&O Laboratories, UK). Bottles were incubated overnight at 37°C before venting. Cultures were examined macroscopically every day, followed by Gram staining if turbid or haemolysed. Subcultures and direct susceptibility testing were performed as directed by the Gram stain findings. Routine subcultures on to sheep blood agar were performed for all bottles after 18-24 hours, 36-48 hours and finally after 7 days. All plates were incubated in a candle jar, and examined after 24 and 48 hours incubation.

Joint fluid was removed by the method that will be outlined below and this was cultured in the following manner:

Table 2.3 Joint Fluid Culture

Test	Method
Joint Fluid Culture	<p>All samples had a Gram stain. Fluids were centrifuged if possible, and the deposit then inoculated onto sheep blood agar and haemophilus test medium, and into a brain heart infusion broth for enrichment. The broth was incubated at 37°C for 48 hours and then subcultured to sheep blood agar and haemophilus test medium. All plates were incubated at 37°C in a candle jar for 48 hours.</p> <p>Isolates were identified according to standard techniques (Ref. Cowan and Steel's Manual for the identification of medical bacteria. 3rd Edition. Eds. Barrow GI, Feltham RKA. Cambridge University Press 1993), including seroagglutination (Pro-Lab Diagnostics, Merseyside, UK and Murex Biotech, Dartford UK) and biochemical tests (API strips, bioMerieux UK Ltd, Basingstoke, UK). Antibiotic susceptibilities were determined by disc diffusion on Mueller-Hinton agar, interpreted using the NCCLS guidelines (Ref. Performance Standards for Antimicrobial Disk Susceptibility Tests. 5<sup>th</sup> Edition. National Committee for Clinical Laboratory Standards. 1993.) For pneumococci, Mueller-Hinton agar with 5% sheep blood was used. Penicillin susceptibility was assessed with a screening technique using a 1µg oxacillin disc. Minimum inhibitory concentrations were not performed for any isolate.</p>

The blood tests above and the joint fluid cultures were performed at the Wellcome Research Centre Laboratory in Blantyre. This is an internationally funded research centre whose laboratories are maintained to a high standard.

The Centre undertakes its own research projects but allows its laboratories to provide services at cost to other recognised studies.

Antero-posterior and lateral X rays of the affected joint were taken on presentation. If there was X ray evidence of any chronic bony infection around the joint such as periosteal elevation, metaphyseal or epiphyseal erosion, the child was not entered into the study as the diagnosis was not simple septic arthritis, and it was likely that the septic arthritis was already complicated by osteomyelitis.

### 2.3.6 Treatment

For the purposes of this study it was important to standardise the pus drainage procedures to be used.

#### 2.3.6.1 Aspiration

For the aspiration group (group 1) the patients were given a general anaesthetic. They had a saline intravenous infusion put into the forearm or antecubital veins of the non dominant or non infected side. They were induced with halothane and oxygen administered using a draw-over technique and an oxygen concentrator. Intravenous pethidine was used as analgesia during the operation and for the immediate postoperative period as needed. The patient's skin surrounding the affected joint was cleaned with povidone iodine aqueous solution then surgical spirit (ethanol), then allowed to dry to reduce contaminants. The operator was masked and wearing sterile gloves. A sterile 14 gauge needle and syringe were used. The following anatomical approaches were used.

## Shoulders.

An anterior approach to the joint was made, inserting the needle below and lateral to the coracoid process. (see figs 2.2 & 2.3)

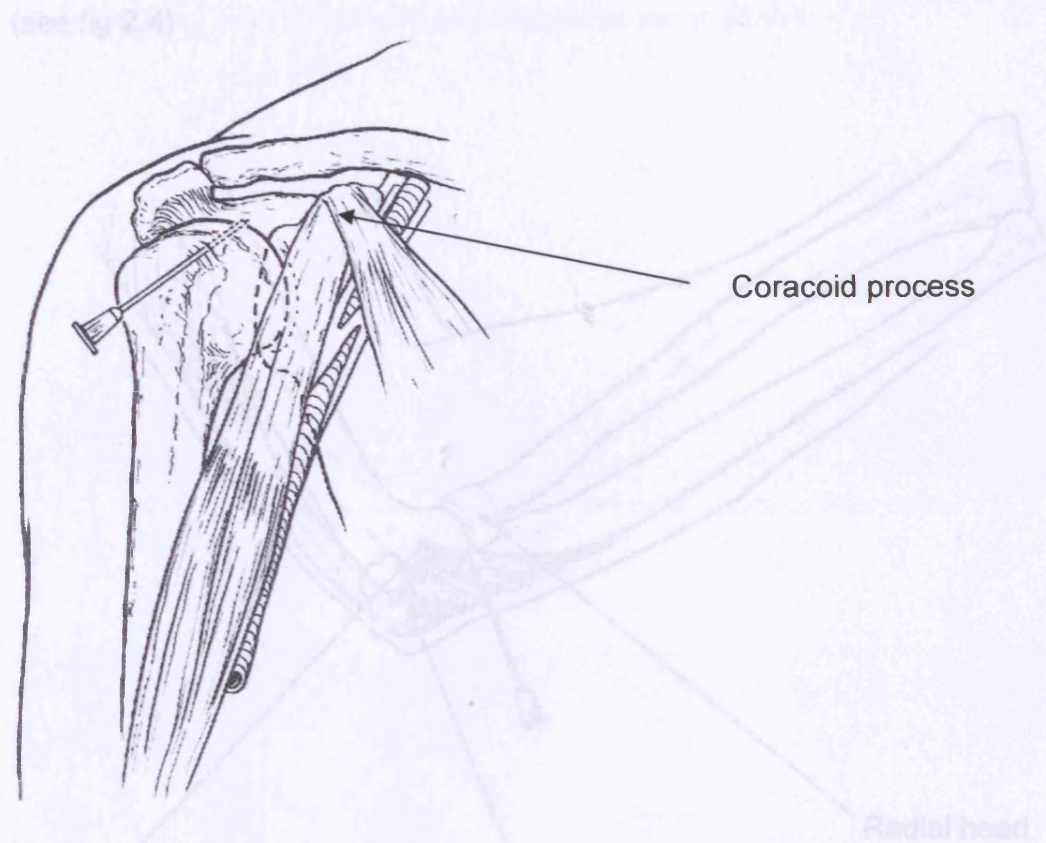


Fig 2.2 Showing outline of anterior approach used in shoulder aspiration.



Fig 2.3 Aspiration of septic shoulder. In this case there was a large collection of pus and the capsule was grossly distended.



## Elbows

A posterolateral approach was used, inserting the needle in the middle of the triangle made by the olecranon, the lateral epicondyle and the radial head.

(see fig 2.4)

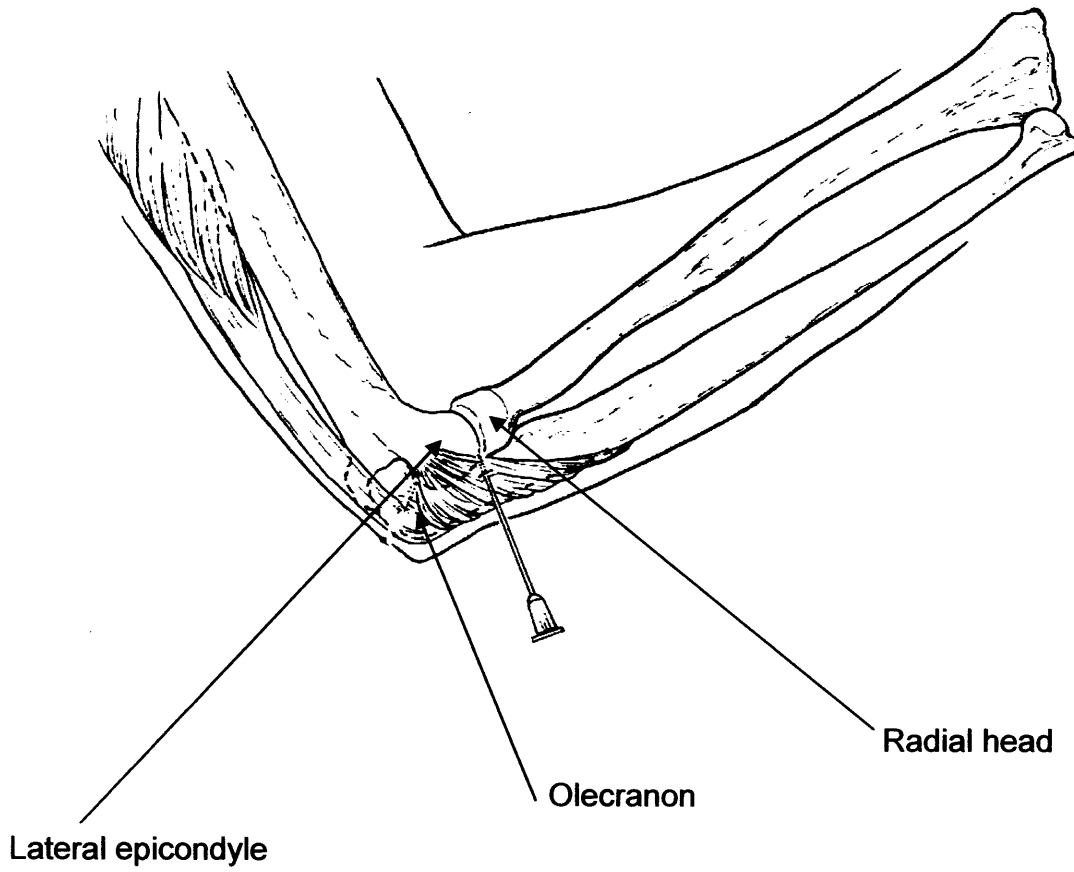


Fig 2.4 landmarks for elbow aspiration

## Hips

The needle was inserted carefully from the lateral side of the thigh just anterior to the greater trochanter, in a superior and medial direction along the femoral neck. (see fig 2.5) Fluoroscopy was not available.

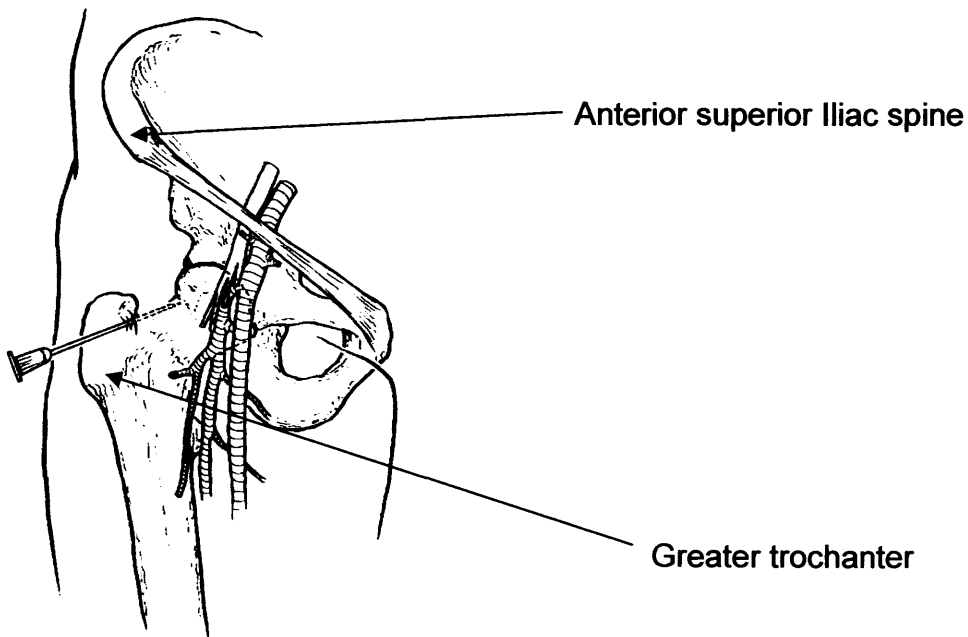
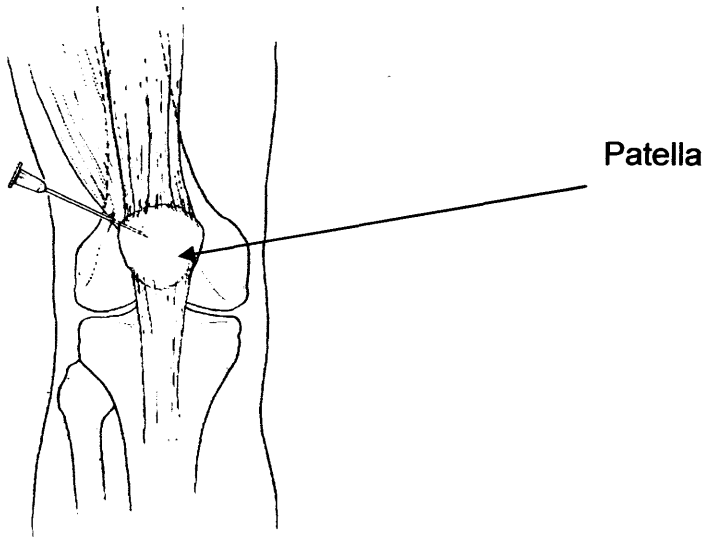


Fig 2.5 landmarks for needle aspiration of hips using an anterolateral approach.

## Knees

A lateral retropatellar approach was used (see fig 2.6)

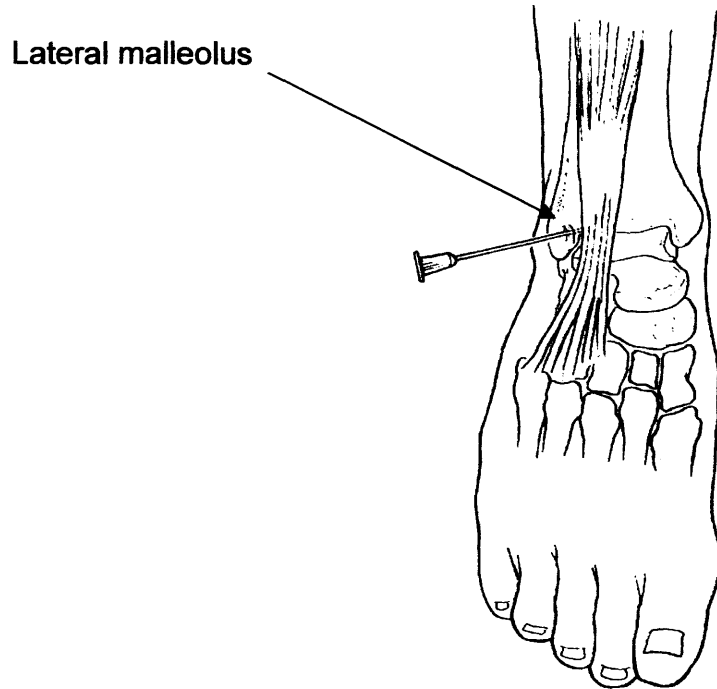
Fig 2.6 landmarks for lateral approach used in knee aspiration.



## Ankles

Either an anteromedial or an anterolateral approach was used, depending on which side was most swollen and fluctuant. (see fig 2.7)

Fig 2.7 Landmarks for anterolateral approach to ankle aspiration



### 2.3.6.2 Arthrotomy and Lavage

A posterolateral incision was made to expose the joint, centring the incision in

For the arthrotomy group (group 2) an identical anaesthetic was used. The patients had a saline intravenous infusion put into the forearm or antecubital veins of the non dominant or non infected side. They were induced with halothane and oxygen administered using a draw-over technique and an oxygen concentrator. Intravenous pethidine was used as analgesia during the operation and for the immediate postoperative period as needed. The preoperative skin preparation was similar to group 1, that is aqueous povidone iodine solution followed by surgical spirit, and the skin was allowed to dry. The operating surgeon was scrubbed and gowned and wore sterile gloves. The joint was draped with sterile towels. The following surgical procedures were used.

#### Shoulders

An anterior deltopectoral approach was made using blunt dissection to split the deltoid and pectoralis major fibres, then the subscapularis fibres, then sharp dissection if necessary to divide the capsule. (see fig 2.8)



Fig 2.8 Anatomical landmarks for skin incision for anterior approach to shoulder

## Elbow

A posterolateral incision was made to expose the joint, centring the incision in the triangle made by the bony prominences of the lateral epicondyle, the olecranon and the head of radius. (see fig 2.9)

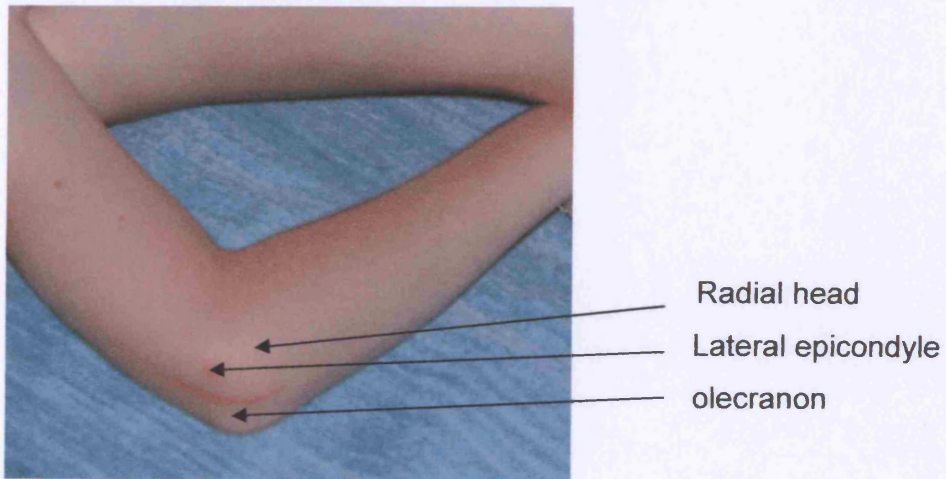


Fig 2.9 Showing landmarks for lateral approach to elbow.

Fig 2.10 showing landmarks of skin incision for open approach of elbow joint using posterior approach.

## Hip

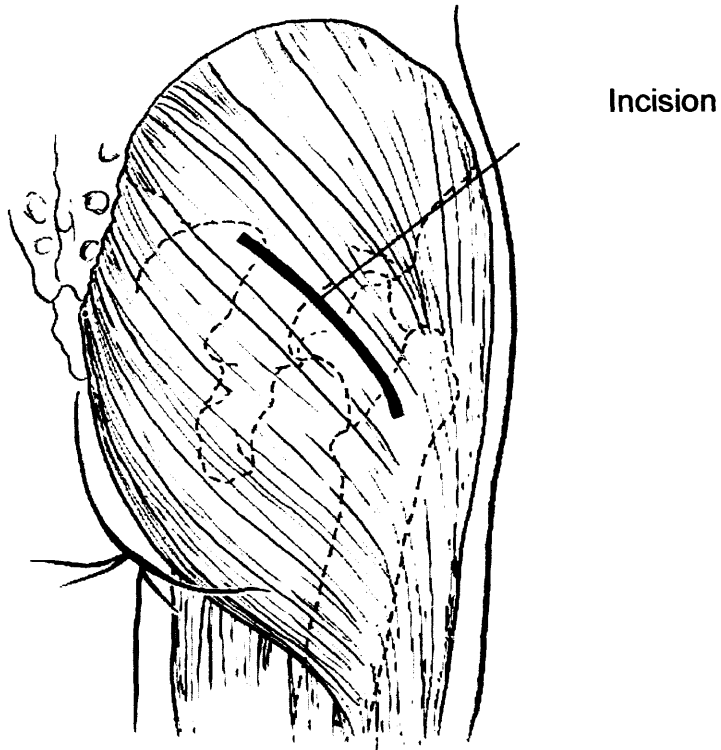
A posterior approach was used, splitting gluteus maximus, taking care that the sciatic nerve was not damaged, and splitting piriformis and the short external rotators before dividing the capsule. (see figs 2.10, 2.11, & 2.12)



Fig 2.10 showing landmarks of skin incision for open drainage of right hip using posterior approach.



Fig 2.12 Development of posterior approach to hip joint showing identification and preservation of sciatic nerve



2.11 Diagrammatic representation of fig 2.10 showing incision overlies hip joint and showing relation of incision to anterior superior iliac crest, greater trochanter and ischial tuberosity

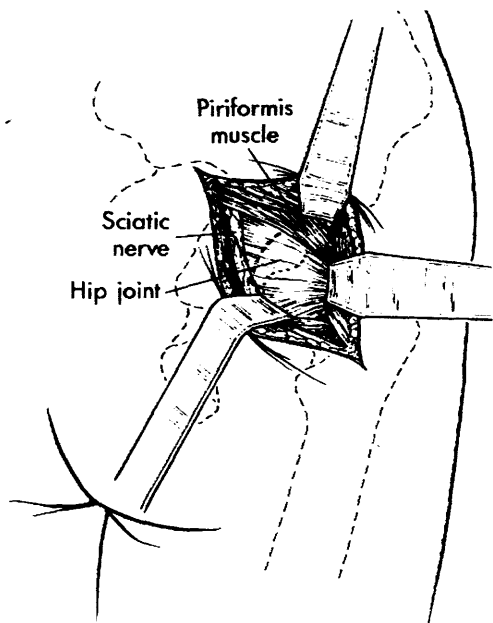


Fig 2.12 Development of posterior approach to hip joint showing identification and preservation of sciatic nerve.



## Knee

A straight lateral parapatellar approach was used. (see figs 2.13 & 2.14)



fig 2.13, Anatomical site for lateral approach to knee joint.



Fig 2.14 Initial incision for arthrotomy of septic knee. In this picture the right knee is being operated on, the hip joint is above the picture and the knee is bent at 90 degrees.

## Ankles

### Treatment in Theatre

A straight anterolateral approach was used approximately one centimetre anterior to the lateral malleolus, (see fig 2.15), unless the main swelling was on the medial side, when the site of maximum fluctuance was opened, taking care to avoid the saphenous vein and nerve.



Fig 2.15 site of incision for lateral approach to septic ankle

In all joints a minimum incision length of 3 cm was used and blunt retractors were inserted into the joint to allow clear inspection of the joint surfaces. A specimen of pus was taken for culture and the rest was sucked out using a sterile mechanical sucker. Sterile saline was then lavaged copiously into the joint which was passively moved to allow all parts of the joint cavity to be thoroughly washed out. A single nylon suture was used to appose the skin edges but no drain was used. Dry gauze dressing was used.

On the ward after the intervention, patients in groups 1 and 2 were reviewed daily with examination of the joint and monitoring of temperature. Intravenous antibiotics started in theatre were continued for 48 hours then changed to oral if the temperature was normal. If the child remained with a fever then intravenous antibiotics were continued for five days. If sensitivity tests showed the organisms to be resistant to chloramphenicol then the antibiotics were immediately changed. If the child was not improving within 48 hours and the joint swelling had recurred or not improved then they referred to

### 2.3.6.3 Treatment in Theatre

Once they had been identified and had enrolled into the study the children proceeded immediately to the operating theatre and were randomised to one of two groups. Randomisation was by the use of sealed envelopes containing computer generated random numbers. Odd numbers were allocated to group 1 (aspiration) and even numbers to group 2 (arthrotomy and lavage). Either aspiration or arthrotomy and lavage as described above were performed. If the aspiration in group 1 was unsuccessful and did not produce pus, then the joint was opened. This was treated as a failure of aspiration and the patient did NOT join group 2. If there was found to be no pus in the joint then the patient was withdrawn from the study as there was no evidence of septic arthritis. Both groups had a dry dressing and returned to the ward with the joint left unsplinted. In the case of hips, if the joint felt unstable in flexion and adduction and it was felt clinically that there was a risk of dislocation then the patient was nursed in abduction, otherwise, and for all other joints, free active movement was allowed, within the patients own pain threshold. As soon as pus was removed from the joint it was sent to the laboratory in a sterile container for microscopy, culture and sensitivity, and the patient was started on intravenous antibiotics. The initial antibiotic used was chloramphenicol as clinical experience at this hospital had shown it to be effective against the common expected organism, namely *Salmonella* (40).

### 2.3.6.4 Ward care and discharge

On the ward after the intervention, patients in groups 1 and 2 were reviewed daily with examination of the joint and monitoring of temperature. Intravenous antibiotics started in theatre were continued for 48 hours then changed to oral if the temperature was normal. If the child remained with a fever then intravenous antibiotics were continued for five days. If sensitivity tests showed the organisms to be resistant to chloramphenicol then the antibiotics were immediately changed. If the child was not improving within 48 hours and the joint swelling had recurred or not improved then they returned to

theatre for a repeat of the same procedure. Thus group 1 had further needle aspiration and group 2 had a further arthrotomy. Oral iron was given if the patient's admission haemoglobin was below 8g/dl. Patients were allowed to go home when they satisfied the discharge criteria outlined below:

- Patient afebrile
- Joint swelling decreased
- Joint non tender to touch
- Active use of affected joint,

Oral antibiotics were given to allow a total antibiotic course of six weeks. To dissuade improper use of antibiotics, patients were only given enough tablets to last them until the next outpatient appointment.

#### 2.3.6.5 Outpatient follow up

After discharge the patients were reviewed in a special research clinic at 2, 6, 12, 24, and 52 weeks. At each attendance X rays were taken, septic scoring of the affected joint was done using the BSJS, and full blood count and ESR were repeated. Patients were refunded travel expenses but were not paid to take part in the study. All treatment remained free of charge to the patient.



Fig 2.16 Follow up research clinic – a mother demonstrating range of movement two weeks after shoulder sepsis



Fig 2.17 Follow up research clinic – patients having blood taken while waiting to be seen

### 2.3.6.6 Defaulters

Patients who did not attend the research clinic were searched for by a follow up team comprising the author or his registrar, a nurse and a driver. (fig 2.18). Detailed descriptive addresses were taken at the time of admission to the study and these were used to try to find the patients. Telephone numbers and street addresses do not work when the patients live in rural villages like those in fig 2.19



Fig 2.18 Follow up team and vehicle

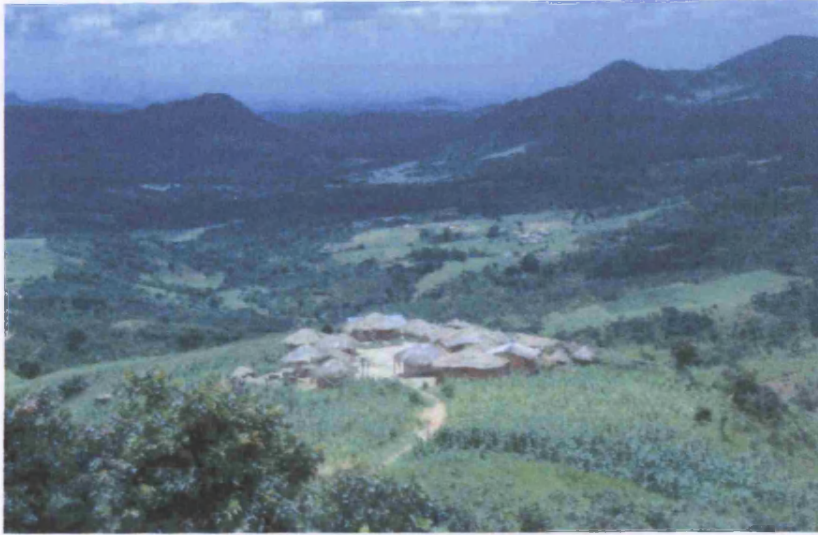
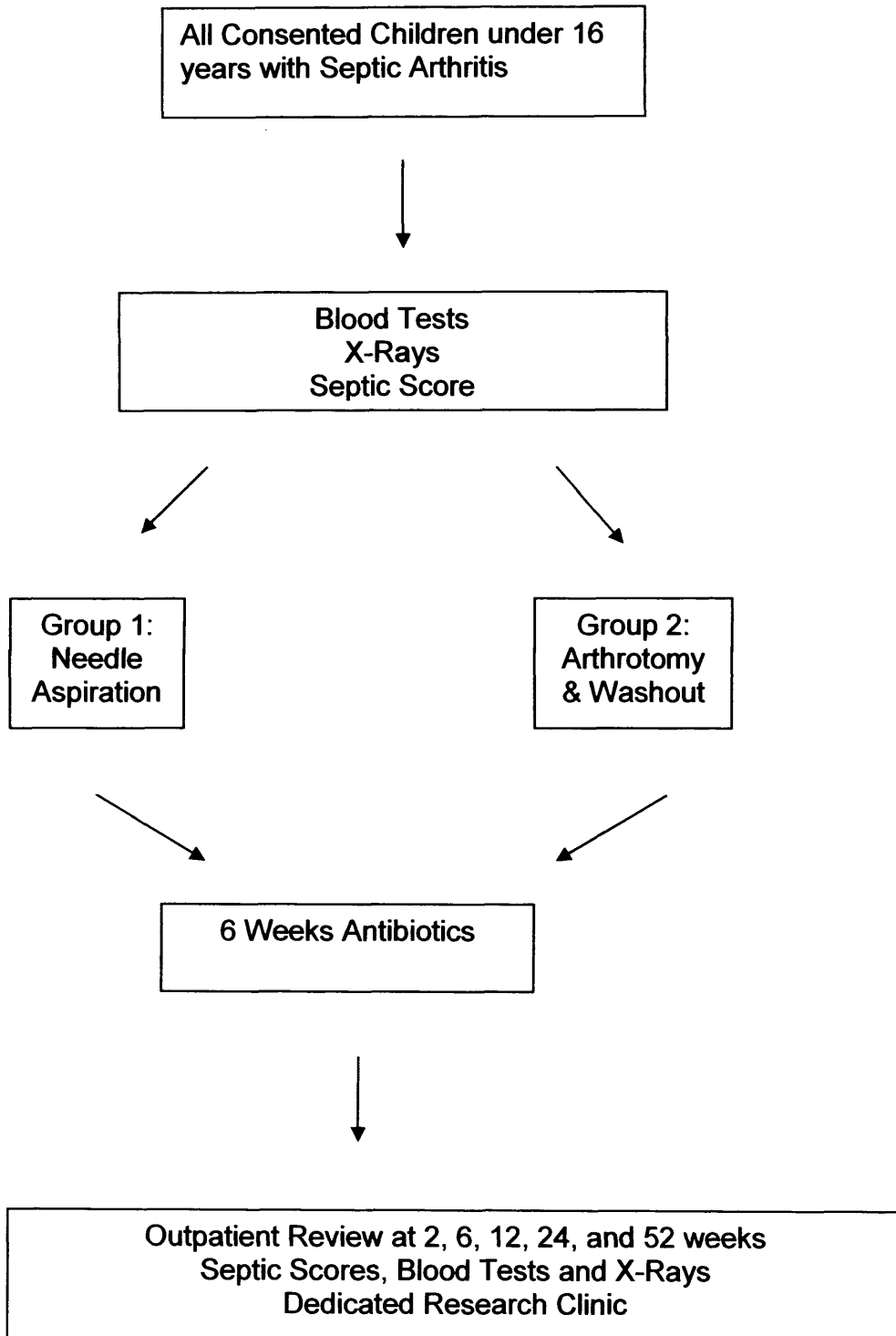


Fig 2.19 A rural village in Malawi

### 2.3.7 Records

Each patient had a standard hospital clinical and laboratory records file and a separate study proforma which was kept in the author's office with the X rays. (For a sample of study proforma see Appendix 3, page 143). Data from the proformas were transferred to a Microsoft Excel programme which allowed statistical analysis. The main statistical test used to compare means between group 1 (aspiration) and group 2 (arthrotomy and lavage) was student's t test. In line with convention in orthopaedic studies a p value of less than 0.05 has been taken as representing a significant difference.

## 2.4 Basic Flow diagram of study





## Chapter 3 Results

### 3.1 Results of Incidence Study

There were a total of 23 cases of septic arthritis under the age of 16 who presented to Chikwawa hospital in the one year study period, of whom 15 were male and 8 female. 16 of these cases were under the age of 5.

This limited study suggests an annual incidence of septic arthritis in children under 5 as 16/71,000 or approximately 1 in 5000, and an annual incidence of septic arthritis in children from 5 to 16 of 7/131,000 or approximately 1/20,000. It is likely that these figures are an under representation as some children will not reach hospital because the parents chose to use alternative treatments. However if it is taken as a rough estimate then this study suggests that children under five in the Chikwawa district have an incidence every year of 1 in 5,000. Thus over the period from birth up to the age of five a child will have a risk of at least 1 in 1000 of having septic arthritis.

### 3.2 Patients in Main Study

The main study started enrolling patients in June 1999 and continued until February 2001 during which time 204 patients had been registered. There was no coercion to enter the study but all patients and guardians who were offered, agreed to take part, and no patient withdrew.

Table 3.2 below shows the characteristics on admission of the patients who entered the main study.

Table 3.2 admission characteristics

	Group 1 (aspiration)	Group 2 (arthrotomy and lavage)	Significance of difference between groups
Number in group	108	96	
Male/female ratio	80/28	57/39	
Age range in months	1-144	1-144	
Mean age in months	29.2 (sd 40.3)	33.3 (sd 43.5)	Not sig (p=0.509, t test)
Weight (expressed as mean % of 50 <sup>th</sup> centile on standard childrens growth chart)	87.0 (sd 18.30)	88.9 (sd 20.8)	Not sig (p=0.503, t test)
Mean Haemoglobin / g/dl	8.76 (range 4.1-14) (sd 2.13)	8.78 (range 5.4-14) (sd 1.9)	Not sig (p=0.9, t test)
Mean White cell count /1000/ mm <sup>3</sup>	13.9 (range 4.1-33.9) (sd 5.78)	14.2 (range 5.9-26.6) (sd 5.16)	Not sig (p=0.82, t test)
Mean ESR	59.4 (range 0-145) (sd 41.4)	58.2 (range 0-140) (sd 40.6)	Not sig (p=0.8, t test)

This table shows that although there was a lower percentage of females in the aspirated group, the other characteristics show no significant differences between the groups.

### 3.3 Follow up rates

These are outlined below. Nine patients died within six months of the study, all of whom were reported by the guardians to have recovered fully from their septic arthritis.

Table 3.3 Follow up rates

Time after presentation	Number still being followed up	Percentage of original number still being followed up
2 weeks	204	100%
6 weeks	204	100%
12 weeks	194	95%
24 weeks	125	65%
52 weeks	65	33%

It can be seen that the follow up rate was excellent up to 12 weeks, but then it tailed off markedly despite attempts at driving to the patients' given addresses.

Of the 9 who died, all deaths were discovered by the follow up team who visited the homes of the patients. All 9 were reported by their families to have recovered from the septic arthritis and to have died from other causes. 2 were in group 1, and 7 in group 2.

### 3.4 Delay Incidence and seasonal variation

The table below indicates the number of patients per month who presented to QECH and were enrolled into the study.

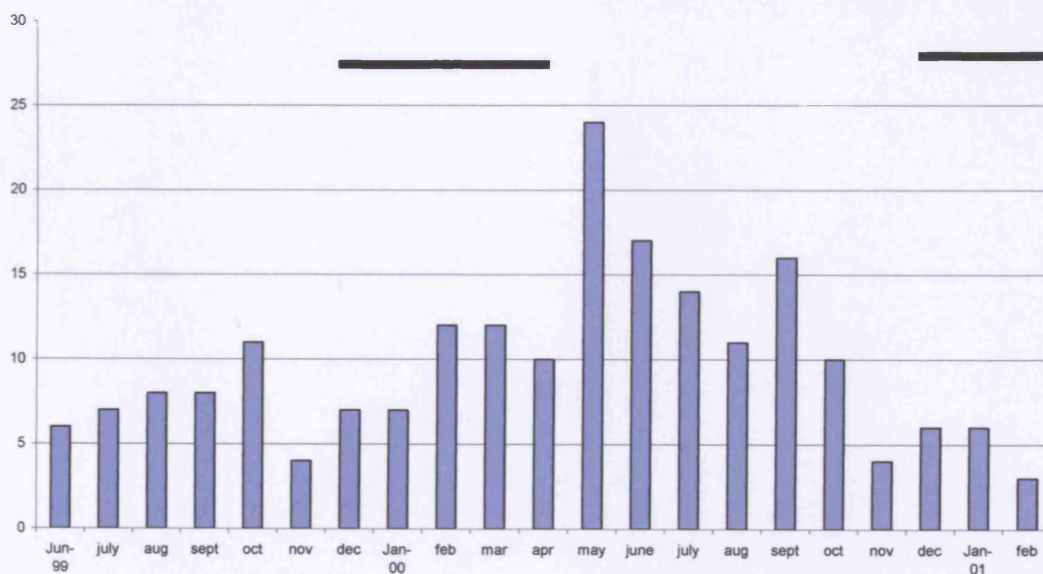
Table 3.4 incidence and seasonal variation

year	1999							2000							2001						
month	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F
incidence	6	7	8	8	11	4	7	7	12	12	10	24	17	14	11	16	10	4	6	6	3

Fig 3.4 Graph of seasonal variation

The same data is expressed below in a graph. The thick black lines indicate the rainy seasons which extend from early December to April. Data were collected over 21 months so not every month appears twice in the graph, and it is difficult to draw a seasonal pattern. However there appears to be a low incidence in November, December and January.

fig 3.4 graph of seasonal variations in incidence of septic arthritis



### 3.5 Delay in presentation

The table below indicates the delay between the start of symptoms as reported by the child or the guardian, and the presentation to QECH, where treatment was immediately started.

Table 3.5 delay in presentation

	Group 1 (aspiration)	Group 2 (lavage)	Significance of difference between groups
Mean number of days from start of symptoms to presentation at hospital	6.05 (range 1-21) (sd 3.70)	7.23 (range 2-21) (sd 4.6)	P=0.067 not sig (t test)

Both groups showed a delay in presentation of approximately one week. This highlights the socioeconomic origins of the patients, many of whom came from rural villages where there is poor transport and limited primary health care.

### 3.6 HIV and sickle cell prevalence

The table below indicates the number of patients in each group who had positive tests for HIV or sickle cell disease. For children below the age of 1 year, the mother was tested for HIV, as HIV testing of the child at this age is not always accurate. Testing was done using the hospital's counselling team and all mothers who were offered gave consent.

Table 3.6 HIV and sickle cell prevalence

Test	Group 1 (aspiration)	Group 2 (lavage)	Significance of difference between groups (Chi squared test)
HIV	9/108	7/96	P=0.19 Not sig
Sickle	1/108	5/96	P=0.014 sig

The HIV prevalence rate is slightly lower than the 10% found by a previous study in children in QECH admitted for trauma (16). There is no published comparison figure for sickle cell prevalence in children in Malawi.

### 3.7 Joints affected

The table below summarises the different joints that were affected in each group.

Table 3.7.1 Joints affected

Joint	Group 1 (aspiration)		Group 2 (lavage)	
	Number	%	Number	%
Shoulder	39	36.1	36	37.5
Elbow	8	7.4	3	3.1
Hip	6	5.5	5	5.2
Knee	47	43.5	38	39.5
Ankle	8	7.4	14	14.6
Total number of patients	108		96	

These results show a similar distribution of joints in both groups as illustrated by the graph below.

Fig 3.7 Graph of joints affected

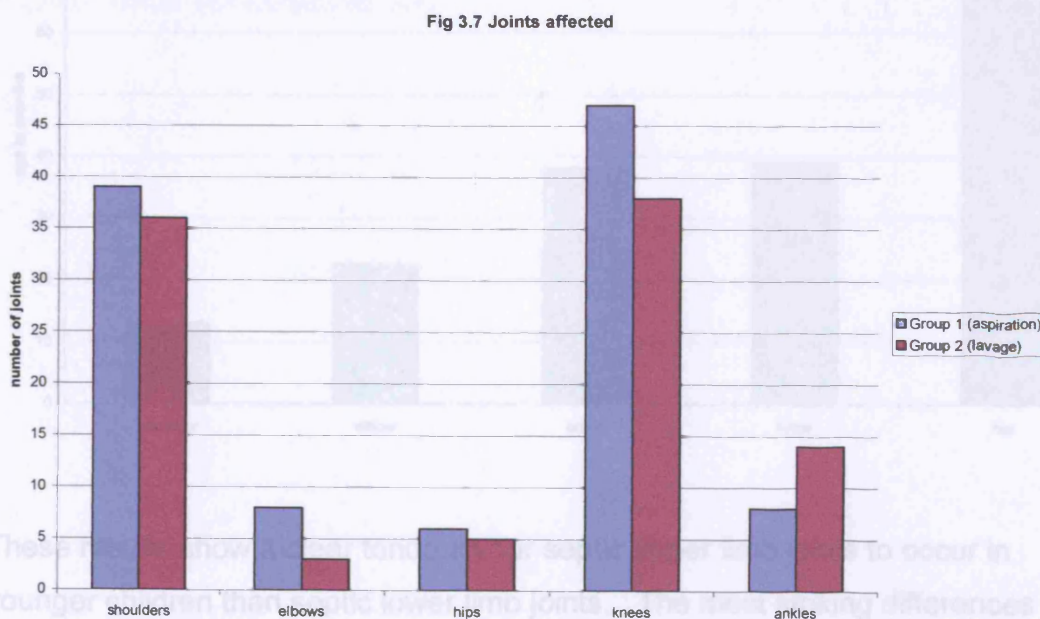


Table 3.7.2 Mean ages for different joints

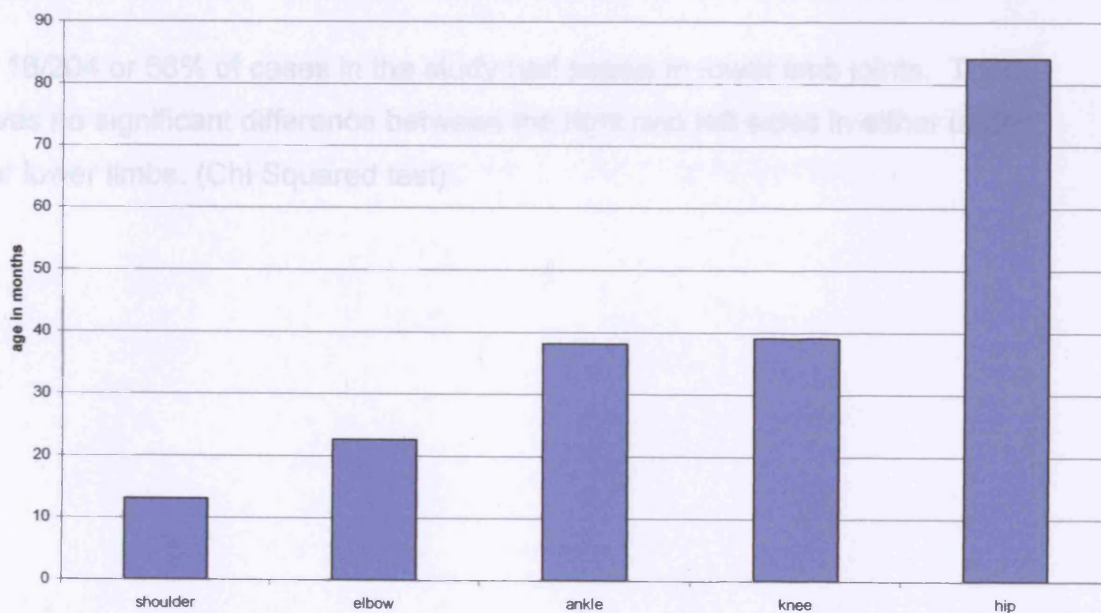
The data from groups 1 and 2 have been combined to see if there is a difference in mean age for different septic joints.

Joint	Mean age (in months)	Standard deviation	range
Shoulder	13.06	20.7	1-144
Elbow	22.64	41.42	1-144
Ankle	38.2	20.72	1-132
Knee	39.09	45.82	1-144
Hip	84.09	54.49	8-144

These results show a tendency for upper limb septic joints to occur in a younger age of patient than lower limb septic joints. This is clearly seen in the graph below

	Left sided	Right side	Total
Upper limb joints	42	44	86
Lower limb joints	69	43	118
Total	101	107	204

Fig 3.7.2 mean ages for different joints



These results show a clear tendency for septic upper limb joints to occur in younger children than septic lower limb joints. The most striking differences



are the shoulder joint where the mean age is 13 months and the hip joint where the mean age is 84 months or 7 years.

The mean age for shoulder joints is significantly lower than the mean for all other joints ( $p=3.2E-6$ , t test). The mean age for hips is significantly higher than the mean for all other joints ( $p=0.0237$ , t test)

### 3.8 Side and limb affected

The table below shows the distributions of left and right sided septic joints and upper and lower limb joints

Table 3.8 Side and limb affected

	Left sided	Right side	Total
Upper limb joints	42	44	86
Lower limb joints	59	59	118
Total	101	103	204

118/204 or 58% of cases in the study had sepsis in lower limb joints. There was no significant difference between the right and left sides in either upper or lower limbs. (Chi Squared test)

### 3.9 Bacteriology

#### 3.9.1 Joint fluid bacteriology

The table below shows the bacteriological cultures grown in the joint fluid of both groups

Table 3.9.1 microbiology of joint fluid for groups 1 & 2

Joint fluid culture	Group 1		Group 2	
	Number of patients	(%)	Number of patients	(%)
No growth	49	45	35	36
<i>S. typhimurium</i>	29	27	18	19
<i>S. enteritidis</i>	6	6	9	9
<i>Staph. aureus</i>	12	11	10	10
<i>H. Influenzae</i>	3	3	11	11
<i>Strep. pyogenes</i>	2	2	10	10
<i>Strep. pneumoniae</i>	6	6	3	3
<i>Klebsiella</i>	1	1	0	0

These results, also displayed graphically below show that as in most published series, there is a high rate of 'no growth'. They also show that the commonest cause overall in both groups is *Salmonella typhimurium*.

Fig 3.9.1 microbiology of joint fluid for groups 1 & 2 (both groups combined)

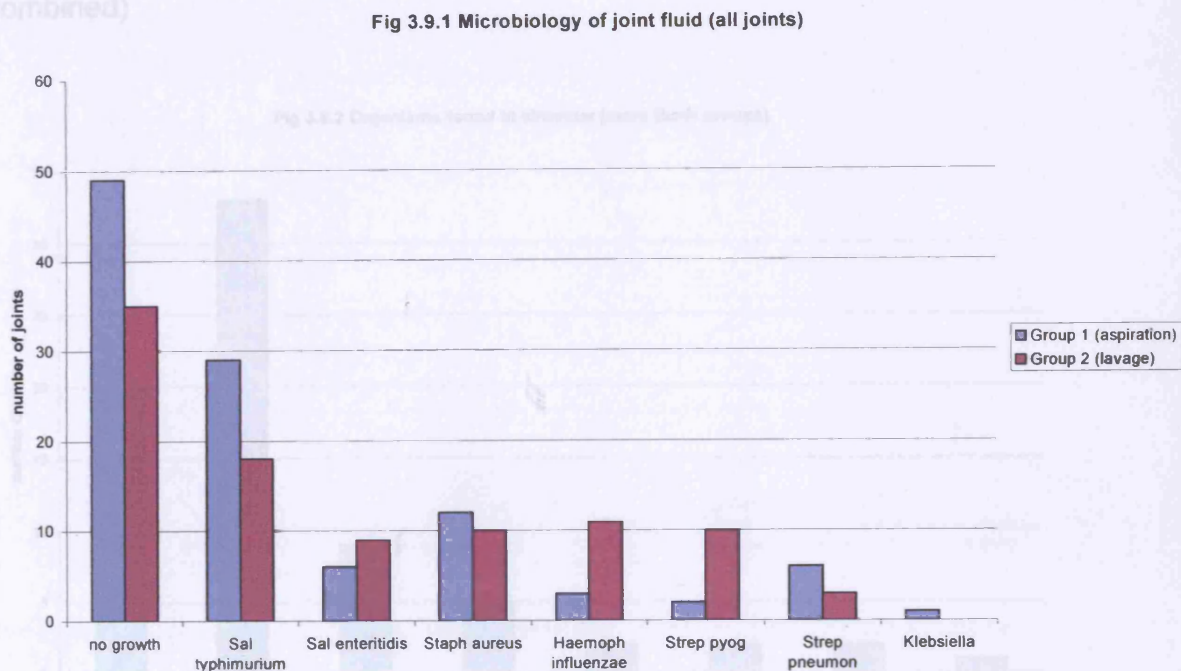
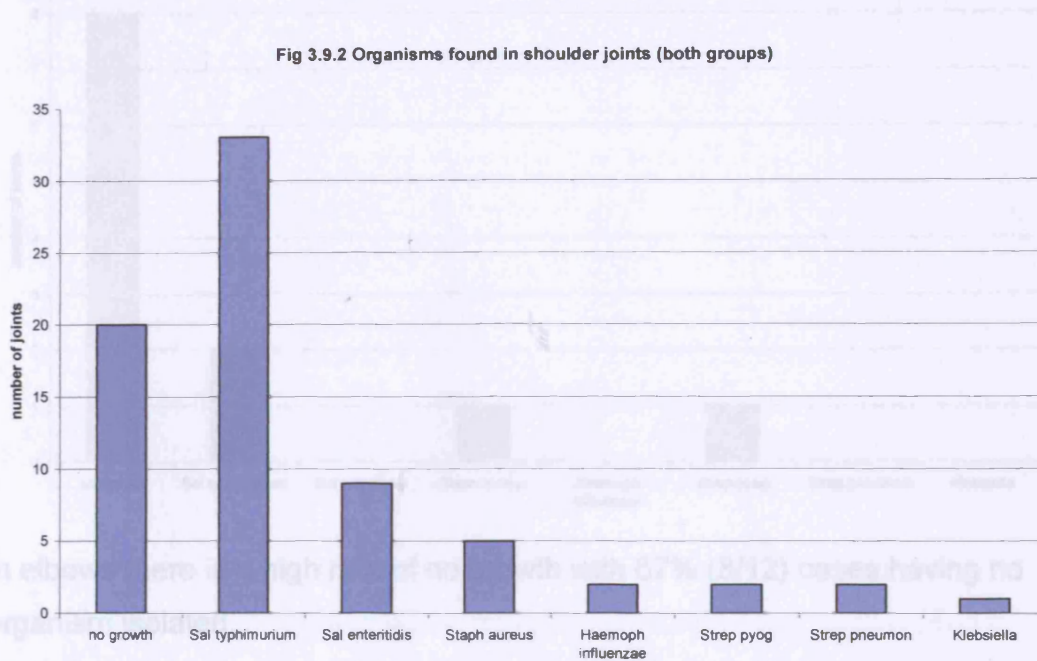


Table 3.9.2 summarises microbiology results for joint fluid culture from different joints. Both groups combined

	shoulder	elbow	hip	knee	ankle
No growth	20	8	3	47	6
<i>S. typhimurium</i>	33	2	1	9	2
<i>S. enteritidis</i>	9			5	1
<i>Staph. aureus</i>	5	1	5	7	4
<i>Strep. pyogenes</i>	2	1	1	7	1
<i>H. influenzae</i>	2		1	7	4
<i>Strep. pneumoniae</i>	2			3	4
<i>Klebsiella</i>	1				

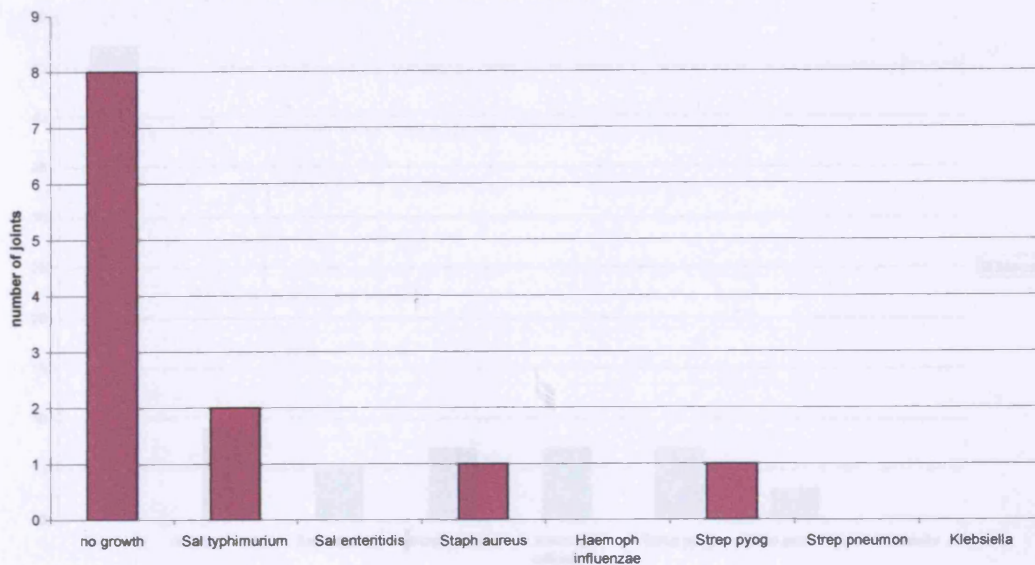
This table and the five graphs that follow (one for each joint) show that *Salmonella* species is the commonest cause of septic arthritis in the shoulder and elbow, while *Staph. aureus* is commonest in the hip. In the ankle and knee the spectrum of bacteria is more mixed. The likelihood of 'no growth' is highest in the knee.

Figs 3.9.2 to 3.9.6 show microbiology results for each joint (both groups combined)



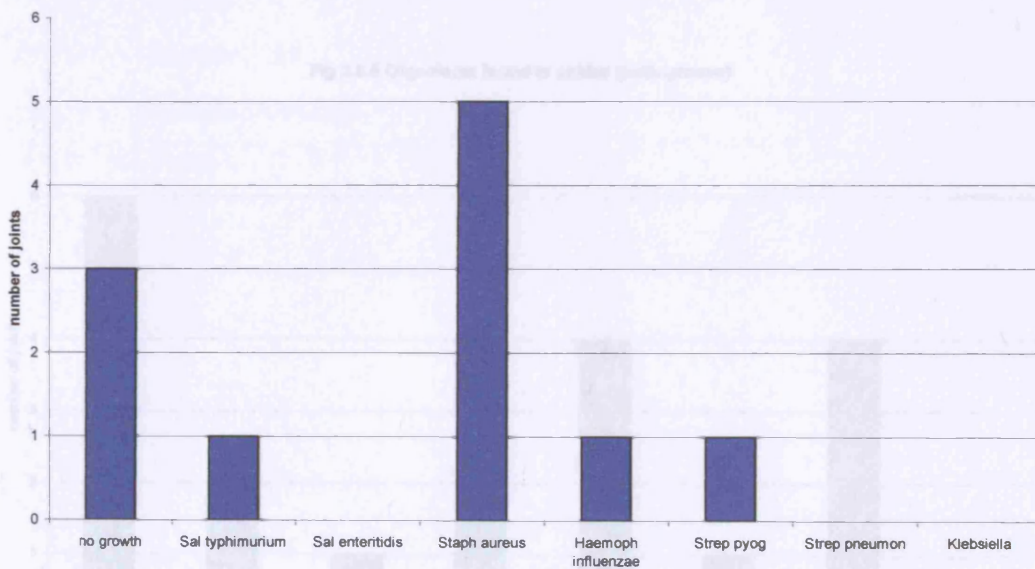
27% (20/75) of cases of shoulder sepsis had no growth, but the commonest organism was *S. typhimurium* with 44% (33/75). If both types of *Salmonella* are considered together they comprise 56% (42/75) of all cases of shoulder sepsis and 76% (42/55) of all shoulder cases where an organism was identified. Thus *Salmonella* predominates in the shoulder.

Fig 3.9.3 Organisms found in elbows (both groups)



In elbows there is a high rate of no growth with 67% (8/12) cases having no organism isolated.

Fig 3.9.4 Organisms found in hips (both groups)

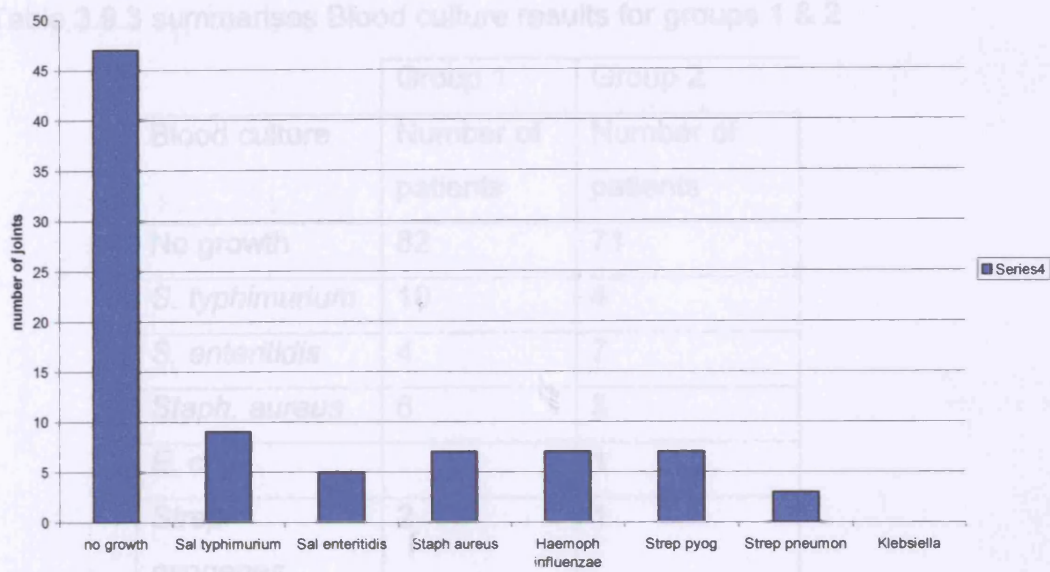


In hips *Staphylococcus aureus* predominates with 5/11 cases.

In hips the no growth rate is 27% (3/11). Where an organism is grown there is a mixed range and, like the knee, *Salmonella* does not predominate.

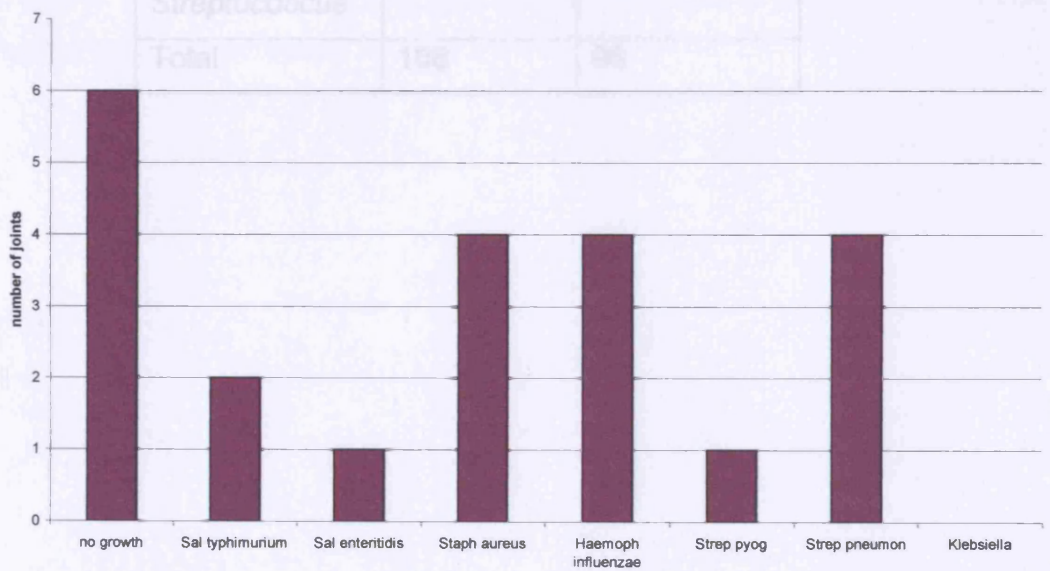
### 3.9.2 Blood culture

Fig 3.9.5 Organisms found in knees (both groups)



In knees the no growth rate is 55% (47/85). Where an organism is isolated, there is no significant predominance of *Salmonella* or any other organism.

Fig 3.9.6 Organisms found in ankles (both groups)



In ankles the no growth rate is 27% (6/22). Where an organism is grown there is a mixed range and, like the knee *Salmonella* does not predominate.

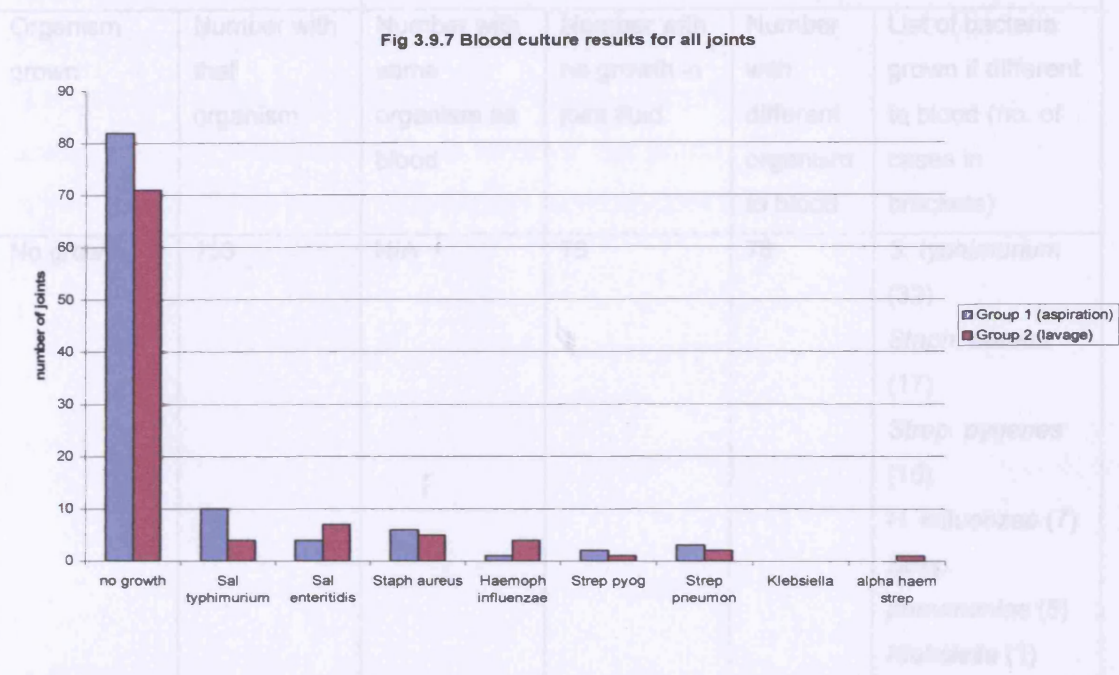
### 3.9.2 Blood culture

Table 3.9.3 summarises Blood culture results for groups 1 & 2

	Group 1	Group 2
Blood culture	Number of patients	Number of patients
No growth	82	71
<i>S. typhimurium</i>	10	4
<i>S. enteritidis</i>	4	7
<i>Staph. aureus</i>	6	5
<i>E. coli</i>		1
<i>Strep. pyogenes</i>	2	1
<i>H. Influenzae</i>	1	4
<i>Strep pneumoniae</i>	3	2
Alpha haemolytic <i>Streptococcus</i>		1
Total	108	96

Table 3.9.4 Correlation of Blood Culture results and Joint Fluid culture results.

Fig 3.9.7 shows these results graphically



The number of patients with 'no growth' on blood culture is higher than for joint fluid culture. However the spectrum of organisms grown on blood culture is similar to that seen from joint fluid culture. The results from blood and joint fluid culture are correlated in table 3.9.4

Organism	Number with that organism	Number with same organism in blood	Number with different organism in blood	List of bacteria grown if different in blood (no. of cases in brackets)
no growth	82	71	11	<i>S. typhimurium</i> (6), <i>Strep pyogenes</i> (1), <i>H. influenzae</i> (1), <i>S. aureus</i> (1), <i>Strep pneumoniae</i> (1), <i>Klebsiella</i> (1), <i>alpha haem strep</i> (1)
Sal typhimurium	10	4	6	<i>Strep pyogenes</i> (1), <i>H. influenzae</i> (1), <i>S. typhimurium</i> (1), <i>Strep pneumoniae</i> (1), <i>E. coli</i> (1), <i>Alpha Haemolytic Strep</i> (1)
Sal enteritidis	7	5	2	<i>Strep pyogenes</i> (1), <i>H. influenzae</i> (1)
Staph aureus	6	5	1	<i>Strep pyogenes</i> (1)
Haemoph influenzae	4	3	1	<i>S. typhimurium</i> (1)
Strep pyog	2	2	0	
Strep pneumon	2	1	1	<i>H. influenzae</i> (1)
Klebsiella	0	0	0	
alpha haem strep	1	0	1	
Totals	204	134	70	



Table 3.9.4 Correlation of Blood Culture results and Joint Fluid culture results.

Blood culture		Joint Fluid culture			
Organism grown	Number with that organism	Number with same organism as blood	Number with no growth in joint fluid	Number with different organism to blood	List of bacteria grown if different to blood (no. of cases in brackets)
No growth	153	N/A	75	78	<i>S. typhimurium</i> (32) <i>Staph. aureus</i> (17) <i>Strep. pyogenes</i> (10) <i>H. influenzae</i> (7) <i>Strep. pneumoniae</i> (5) <i>Klebsiella</i> (1)
<i>S. typhimurium</i>	14	13	1	0	
<i>S. enteritidis</i>	11	4	3	4	<i>Staph. aureus</i> (1) <i>Strep pyogenes</i> (1) <i>H. influenzae</i> (1) <i>S. typhimurium</i> (1)
<i>Staph. aureus</i>	11	8	2	1	<i>Strep. pyogenes</i> (1)
<i>H. Influenzae</i>	5	5	0	0	
<i>Strep. pneumoniae</i>	5	4	0	1	<i>Staph. aureus</i> (1)
<i>Strep. pyogenes</i>	3	0	2	1	<i>S. typhimurium</i> (1)
<i>E coli</i>	1	0	0	1	<i>H. influenzae</i> (1)
Alpha Haemolytic <i>Strep.</i>	1	0	1	0	
Totals	204	34	84	86	

Tables 3.9.3 and 3.9.4 show that blood culture in septic arthritis has a low rate of bacterial isolation, with only 25% (51/204) patients having a positive blood culture. However of those 51 patients with a positive blood culture, in 67% (31/51) there was a positive correlation with joint fluid culture. The correlation is especially high if *Salmonella typhimurium*, *Staph. aureus*, *Strep. pneumoniae* or *H. influenzae* is isolated in the blood. For example in 13 of the 14 cases (93%) where *Salmonella typhimurium* was cultured in the blood it was also cultured in the joint fluid.

### 3.10 Drainage method failures

Drainage failure is defined as failure of the randomised method (either aspiration or arthroscopy) to drain or remove any pus when there is pus present.

Table 3.10 summarises drainage failures

Group	Joint	Number in group	Successful drainage ie pus removed from joint using randomised method	unsuccessful drainage using randomised method	Repeat of randomised drainage method needed because of reaccumulation
Group 1 Aspir.	Shoulder	39	38	1	4
	Elbow	8	8	0	0
	Hip	6	5	1	0
	Knee	47	44	3	8
	Ankle	8	7	1	1
	All joints	108	102	6	13
Group 2 lavage	Shoulder	36	36	0	1
	Elbow	3	3	0	0
	Hip	55	55	0	0
	Knee	38	38	0	0
	Ankle	14	14	0	1
	All joints	96	96	0	2

There were two important differences between the groups. Firstly a total of 6 patients in group 1 went on to have an arthroscopy as aspiration failed to produce pus. By contrast in group 2 there were no failures as arthroscopy (by definition) revealed pus in all cases.

The second important difference is that a repeat procedure was needed in 12% (13/108) patients in group 1 compared to only 2% (2/96) patients in group 2 (significant,  $p < 0.005$  using chi squared test)

### 3.11 Temperature

The table below shows axillary temperature in degrees Centigrade on admission, and the mean number of days until the temperature returned to normal.

Table 3.11 Temperature

	Group 1	Group 2	Significance of difference between groups
Mean Temperature on admission /degrees C	37.76 (range 35.7-40) (sd 0.98)	37.69 (range 36.2-40) (sd 0.93)	P=0.81 Not sig (t test)
Mean number of days until temperature normal	1.75 (range 0-7) (sd 1.86)	1.47 (range 0-6) (sd 1.7)	P=0.22 Not sig (t test)

There was no significant difference between the two groups in either the temperature on admission or the number of days taken for the temperature to return to normal in response to treatment.

### 3.12 Time to discharge

The table below shows the mean time in days until the discharge criteria were reached, for all the patients in each group, including those who had repeat drainage procedures. The discharge criteria were:

- Patient afebrile
- Joint swelling decreased
- Joint non tender to touch
- Active use of affected joint

The patients in group 1 were discharged a mean of 1.6 days earlier than those in group 2. The difference is statistically significant.

Table 3.12 Time to discharge

	Group 1	Group 2	Significance of difference between groups
Mean number of days until discharge	7.1 (range 3-21) (sd 4.0)	8.7 (range 3-20) (sd 3.9)	p=0.0049 sig* (t test)

### 3.13 Blantyre Septic Joint Score

The Blantyre Septic Joint Score (which has been described in chapter 2) is an independently verified clinical scoring method for septic joints (110). It assesses swelling, tenderness, range of movement and function and gives an overall clinical score for the joint. A normal joint would score 16 and the worst possible score is 4.

Table 3.13 Blantyre Septic Joint Scores

This table excludes the six patients in group 1 where aspiration was not possible and had to be abandoned.

		Mean BSJS scores					
Group	Joint	Pre-sen-tation	2 weeks	6 weeks	12 weeks	24 weeks	52 weeks
Group 1 Aspir.	Shoulder	7.13	15.4	16	15.97	16	16
	Elbow	7.63	15.5	16	16	16	16
	Hip	8.17	14.3	16	15.6	15.5	15
	Knee	7.15*	15.5	16	15.98	16	16
	Ankle	7.13	15.6	16	16	16	16
	All joints	7.23 <sup>#</sup>	15.4	16	15.96	15.95	15.9
Group 2 lavage	Shoulder	6.87	15.5	15.9	16	16	16
	Elbow	7.5	15	16	16	16	16
	Hip	7.2	14	15.6	15.6	15.3	14
	Knee	6.32*	15.1	16	15.97	16	16
	Ankle	6.07	15.4	16	16	16	16
	All joints	6.57 <sup>#</sup>	15.2	15.9	15.97	15.95	15.9

#### Notes

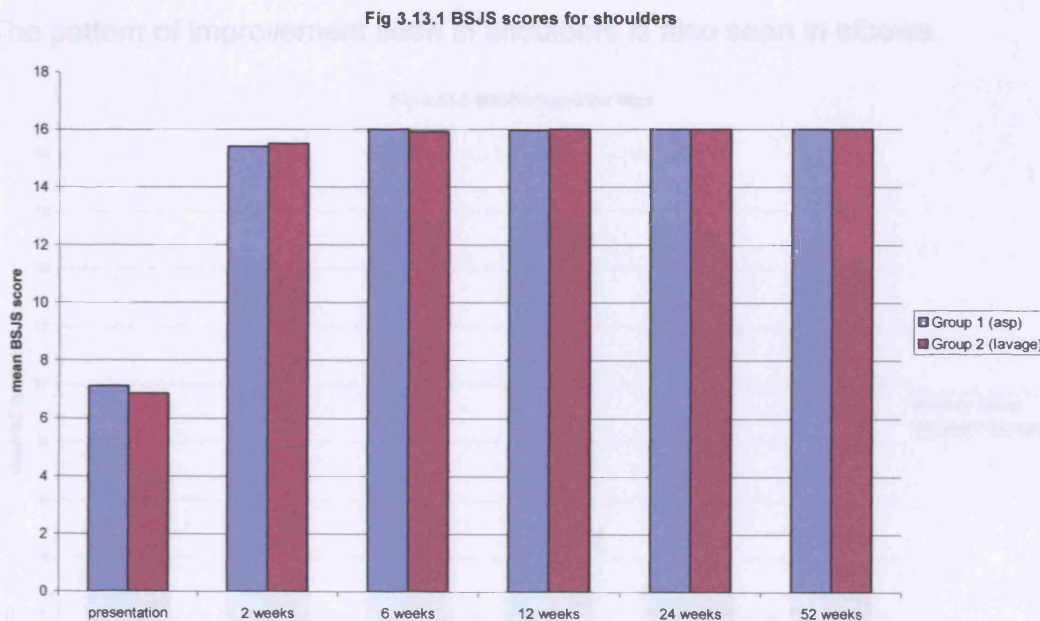
\*There is a significant difference between the mean BSJS for knees in groups 1 and 2 at presentation. ( $p=0.02$  t test) This significance is lost after two weeks. <sup>#</sup>There is also a significant difference between the mean BSJS at

presentation for all joints in groups one and two,  $p=0.005$ . (t test) Again the significance is lost after two weeks.

Note the rapid return of most BSJS scores to almost normal by six weeks.

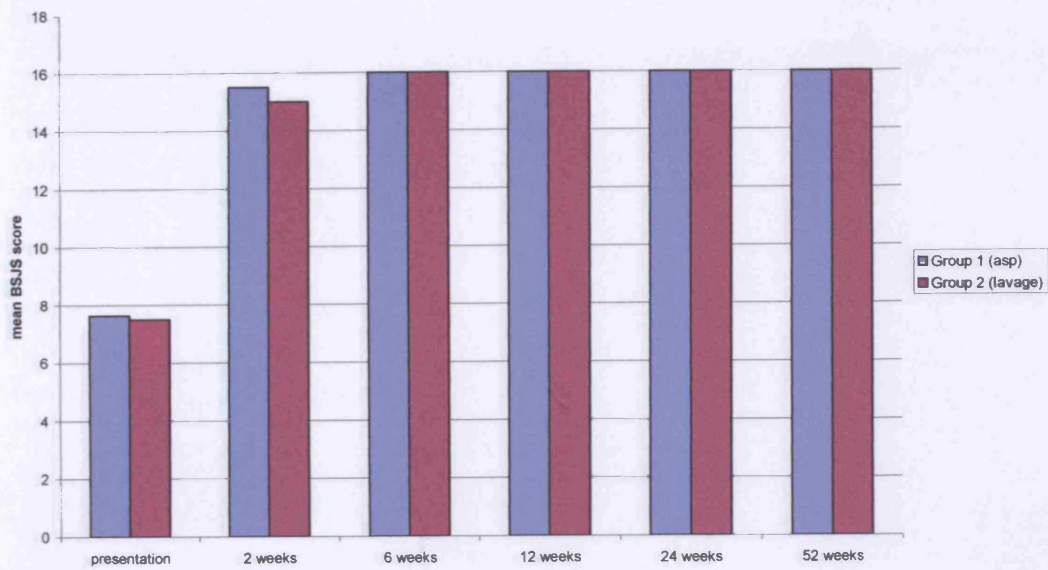
This is also illustrated in the graphs that follow. In all joints there were no clinical signs of infection or inflammation at six weeks. The only joint in either group where there was a failure to return to a score of 15.9 or better at 6 weeks was the hip. The cause of this was collapse of one femoral head in each group and the consequent loss of function and increase in pain. Both these cases are illustrated later in this chapter.

Fig 3.13.1 to 6 Graphs showing improvement in BSJS for individual joints and all joints



BSJS scores for shoulders show a big increase in score between presentation and 2 weeks and a further increase between 2 and 6 weeks to virtually normal function, which is then maintained.

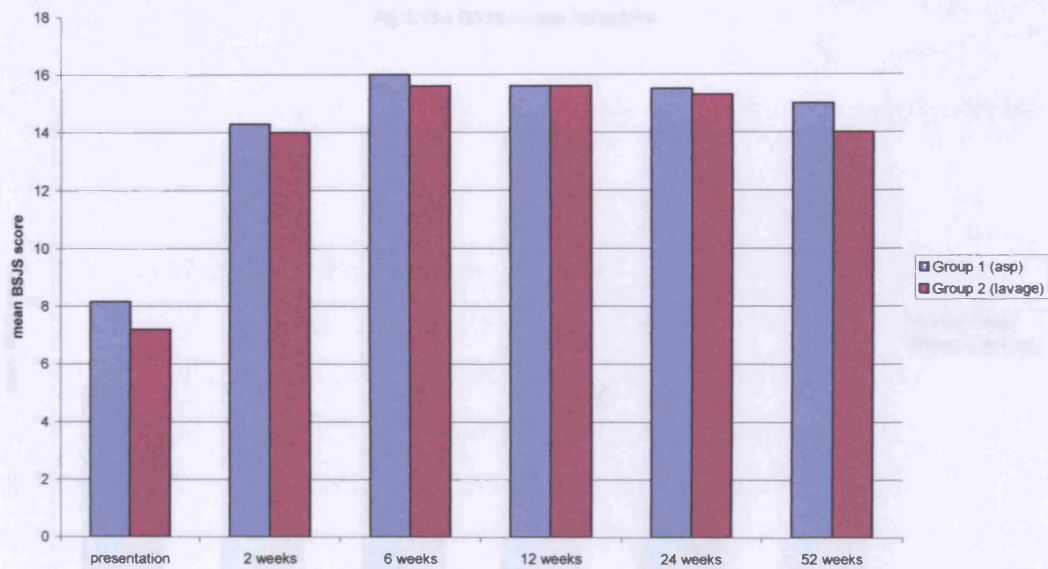
Fig 3.13.2 BSJS scores for elbows



BSJS scores for knees are similar to those seen in shoulders and elbows.

The pattern of improvement seen in shoulders is also seen in elbows.

Fig 3.13.3 BSJS scores for hips

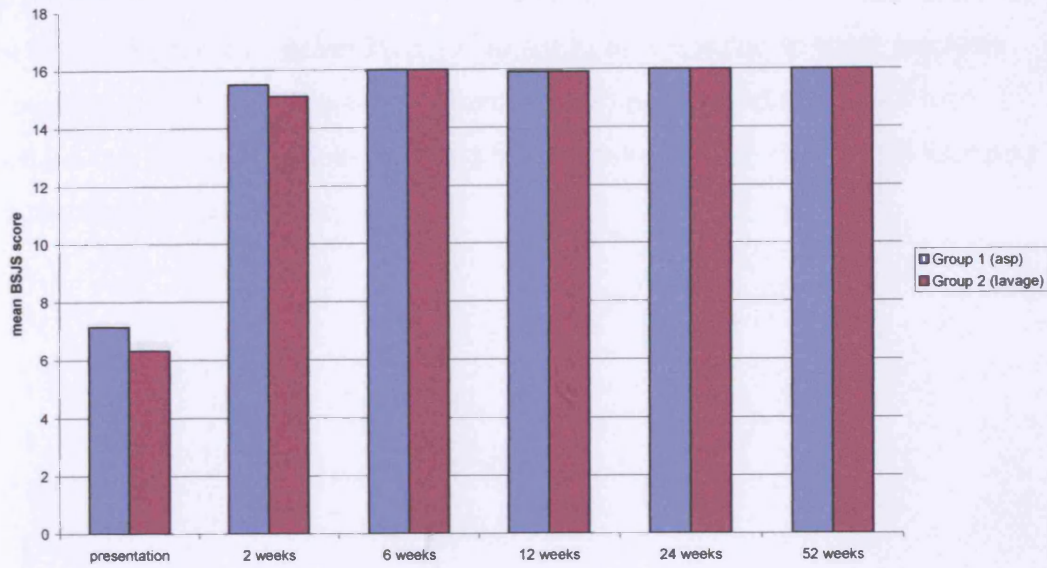


BSJS scores for hips show the normal early improvement up to six weeks, but then function slowly deteriorates.

KNEES

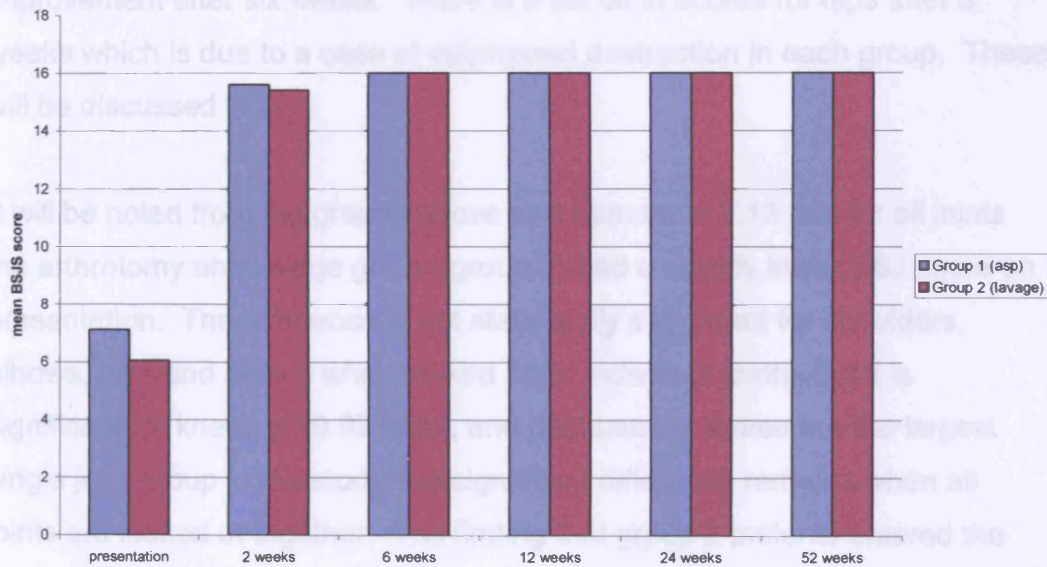


Fig 3.13.4 BSJS scores for knees



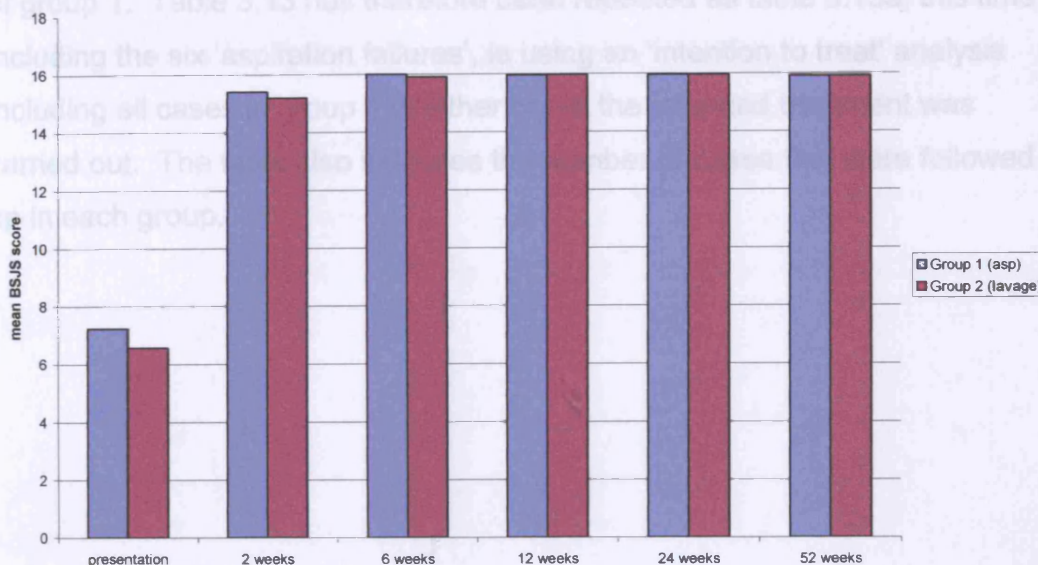
BSJS scores for knees are similar to those seen in shoulders and elbows.

Fig 3.13.5 BSJS scores for ankles



BSJS scores for ankles follow the pattern seen in shoulders, elbows and knees.

Fig 3.13.6 BSJS scores for all joints together



All joints showed a marked increase in BSJS scores between presentation and 2 weeks, and a further increase between 2 and 6 weeks, by when most joints were at near maximal scores. There was thus little further clinical improvement after six weeks. There is a tail off in scores for hips after 6 weeks which is due to a case of epiphyseal destruction in each group. These will be discussed later.

It will be noted from the graphs above and from table 3.13 that for all joints the arthrotomy and lavage group (group 2) had a slightly lower BSJ score on presentation. The difference is not statistically significant for shoulders, elbows, hips and ankles when looked at for individual joints, but it is significant for knees ( $p=0.02$  ttest), and because the knees are the largest single joint group in the study this significant difference remains when all joints are looked at together. The finding that group 2 patients entered the study with a slightly worse BSJ score than group 1 patients would have been consistent with a policy of offering the more extensive treatment option (arthrotomy and lavage) to the cases that appeared worse clinically. However this did not happen as randomisation was performed on entry to the study according to the protocol outlined in 2.3.6.3 (page 56). It was certainly a possibility that the six cases in which aspiration had failed were particularly

serious cases and that their removal from analysis reduced the mean severity of group 1. Table 3.13 has therefore been repeated as table 3.13a, this time including the six 'aspiration failures', ie using an 'intention to treat' analysis including all cases in group 1 whether or not the intended treatment was carried out. The table also indicates the number of cases that were followed up in each group.

Table 3.13a Blantyre Septic Joint Scores over time for both groups (using an 'intention to treat' analysis) The number in brackets (n) in each box is the number of cases still being followed up at that time.

		Mean	BSJS	scores (n)			
Group	Joint	Present- ation	2 weeks	6 weeks	12 weeks	24 weeks	52 weeks
Group 1 Aspir.	Shoulder	7.05 (39)	15.4 (39)	16 (39)	15.97 (37)	16 (26)	16 (9)
	Elbow	7.63 (8)	15.5 (8)	16 (8)	16 (8)	16 (3)	16 (3)
	Hip	8.43 (6)	14.3 (6)	16 (6)	15.6 (5)	15.5 (2)	15 (2)
	Knee	7.2 (47)	15.5 (47)	16 (47)	15.98 (45)	16 (29)	16 (21)
	Ankle	6.89 (8)	15.6 (8)	16 (8)	16 (7)	16 (3)	16 (2)
	All joints	7.20 (108)	15.4 (108)	16 (108)	15.96 (102)	15.95 (63)	15.9 (37)
Group 2 lavage	Shoulder	6.87 (36)	15.5 (36)	15.9 (36)	16 (33)	16 (24)	16 (11)
	Elbow	7.5 (3)	15 (3)	16 (3)	16 (3)	16 (1)	16 (1)
	Hip	7.2 (5)	14 (5)	15.6 (5)	15.6 (5)	15.3 (3)	14 (1)
	Knee	6.32 (38)	15.1 (38)	16 (38)	15.97 (37)	16 (26)	16 (10)
	Ankle	6.07 (14)	15.4 (14)	16 (14)	16 (14)	16 (8)	16 (5)
	All joints	6.57 (96)	15.2 (96)	15.9 (96)	15.97 (92)	15.95 (62)	15.9 (28)

It will be seen from comparing this table to table 3.13 that addition of the six cases where aspiration failed does not materially affect the difference that is seen between the BSJ scores at initial presentation for knees in groups 1 & 2, or the difference that is seen for all joints.

Further analysis of the six cases of aspiration failure, (1 shoulder, 3 knees, 1 hip and 1 ankle) showed a mean presentation BSJ score of 7.16 compared to 7.23 for the rest of group 1, and a mean presentation delay of 6 days compared to 6.05 days for the rest of group 1. Neither of these differences were significant using ttest. ( $p=0.96$  and  $p=0.93$  respectively). Thus there appears to be no measurable difference in these two parameters between cases where aspiration fails and those where it succeeds.

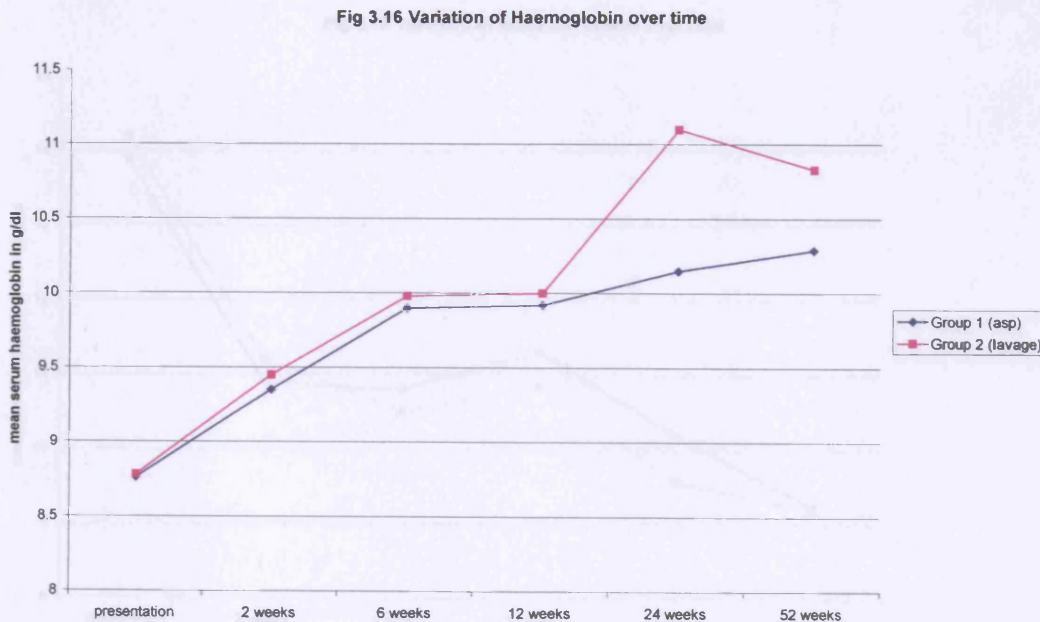
In an effort to look for other factors that might have influenced the knees in group 1 having a higher mean BSJ score than the knees in group 2 all individual knee BSJ scores were looked at. When all knees were looked at there were six high scoring cases where the initial BSJ score was above 10. Five out of these six fell into group 1 compared to only one case in group 2. It could be that a chance unequal split of these high scoring cases is the cause of the difference between the two groups.

### 3.14 Haemoglobin cell count

Table 3.14 Haemoglobin levels in g/dl for both groups over time

Haemoglobin	Group 1		Group 2		Significance of difference between groups (t test)
	Mean	SD	Mean	SD	
on presentation	8.76	2.13	8.78	1.9	P=0.9 NS
at 2 weeks	9.35	1.91	9.45	1.91	P=0.72 NS
at 6 weeks	9.9	1.96	9.98	1.9	P=0.89 NS
at 12 weeks	9.92	1.76	10	1.85	P=0.82 NS
at 24 weeks	10.15	2.14	11.1	1.5	P=0.043 sig*
at 52 weeks	10.29	2.27	10.83	2.20	P=0.34 NS

Fig 3.14 Haemoglobin levels over time for both groups



Haemoglobin levels increased in both groups as the infection was treated. There was a marked difference between the two groups at 24 weeks, but this disappeared by 52 weeks.

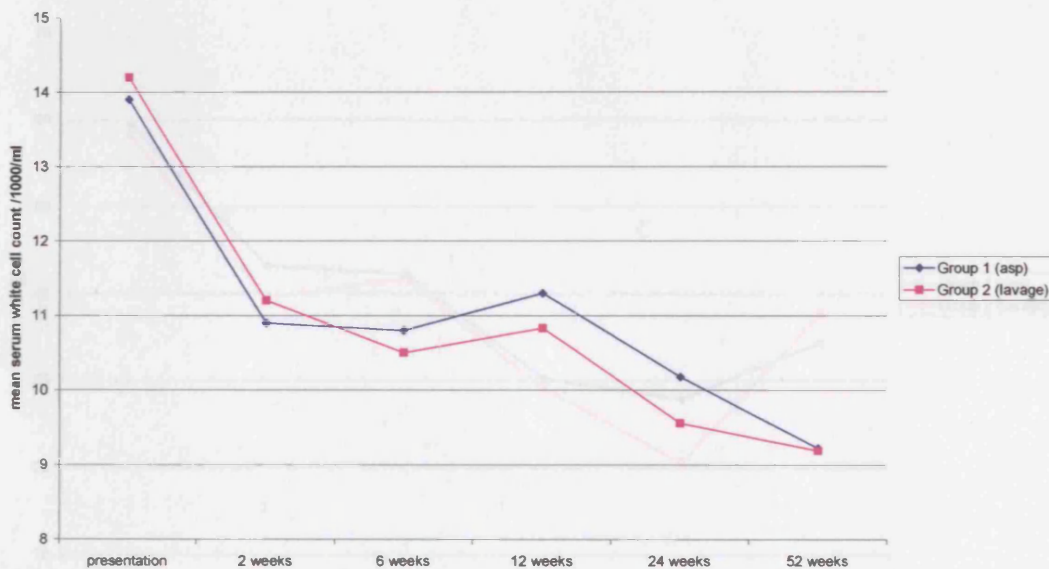
### 3.15 Serum white cell count

Table 3.15 Serum white cell counts (expressed as /1000 cells/mm<sup>3</sup>) for both groups over time

White cell count	Group 1		Group 2		Significance of difference between groups (t test)
	Mean	SD	Mean	SD	
on presentation	13.9	5.78	14.2	5.16	P=0.82 NS
at 2 weeks	10.9	4.13	11.2	5.11	P=0.74 NS
at 6 weeks	10.8	4.57	10.5	4.62	P=0.73 NS
at 12 weeks	11.3	5.61	10.83	3.41	P=0.94 NS
at 24 weeks	10.18	4.15	9.56	3.25	P=0.71 NS
at 52 weeks	9.22	2.30	9.19	2.776	P=0.9 NS

Fig 3.15 Serum white cell counts for both groups over time

Fig 3.15 Variation of white cell counts over time



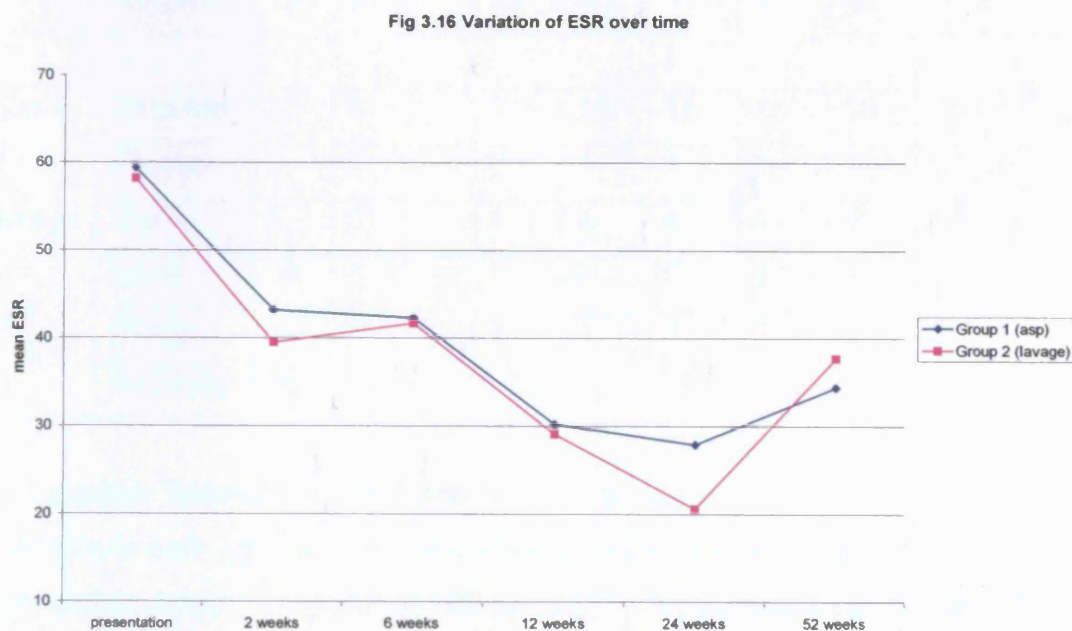
The serum white cell count decreased for both groups over time as the infection was treated. The reason for the rise in white cell count in both groups at 12 weeks is not clear.

### 3.16 ESR

Table 3.16 ESR for both groups over time

ESR	Group 1		Group 2		Significance of difference between groups (t test)
	Mean	SD	Mean	SD	
on presentation	59.4	41.4	58.2	40.6	P=0.85 NS
at 2 weeks	43.2	37.5	39.5	34.2	P=0.29 NS
at 6 weeks	42.3	35.7	41.7	31.2	P=0.52 NS
at 12 weeks	30.2	30.4	29.1	32.2	P=0.93 NS
at 24 weeks	27.9	31.4	20.6	28.9	P=0.48 NS
at 52 weeks	34.4	29	37.74	32.1	P=0.66 NS

Fig 3.16 ESR for both groups over time



ESR levels fall for both groups as the joint sepsis settles. The reason for the slight increase at 52 weeks in both groups is not clear.



### 3.17 X ray changes

There were many X ray changes seen around the joints as the study progressed. These are outlined in detail for individual joints in 3.17.3 (starting on page 95). It is difficult to equate the clinical significance of for example an epiphyseal erosion in the shoulder with a case of periosteal elevation around the knee, as they are in different joints and may lead to different outcomes. However as none of the cases had X ray changes on admission because of the exclusion criteria for study entry, any case where X ray changes occur is a case where septic arthritis may be progressing towards osteomyelitis, and such cases are clearly in a more complicated category than those where there are no bony changes at all. It is thus reasonable to split the cases into 2 broad categories: on the one hand those with no X ray changes at all, and on the other those with X ray changes and a suggestion of bone infection.

Table 3.17 documents the x ray changes over time for the different joints in group 1 and group 2.

Table 3.17 X ray changes over time for all joints

Note that there were no patients with X ray changes on admission as this was one of the exclusion criteria for the study.

		Number of patients with X ray changes by this time							% with known X ray changes by 52 weeks
Group	Joint	No	Prese- ntation	2 wks	6 wks	12 wks	24 wks	52 wks	
Group 1 Aspir.	Shoulder	39	0	10	20	20	20	20	51.3
	Elbow	8	0	3	3	3	3	3	37.5
	Hip	6	0	1	3	3	3	3	50
	Knee	47	0	3	8	9	9	9	19.1
	Ankle	8	0	5	6	6	6	6	75
	All joints	108	0	22	40	41	41	41	37.9
Group 2 lavage	Shoulder	36	0	7	18	18	18	18	50
	Elbow	3	0	0	1	1	1	1	33.3
	Hip	5	0	1	4	4	4	4	80
	Knee	38	0	7	8	8	8	8	21
	Ankle	14	0	2	6	6	6	6	50
	All joints	96	0	17	37	37	37	37	39.5

Comparison between Group 1 and group 2 shows a similar spread of X ray changes in both groups. The total number of joints which develop X ray changes in group 1 is 41 out of 108 joints (37.9%) compared to 37 out of 96 joints in group 2 (39.5%) This is not significant (chi squared test)

It is of interest that in both groups where X ray changes are going to occur, just over half of them have appeared by two weeks (22/41 in group 1, and

17/37 in group 2). The remainder have almost all occurred by six weeks, (40/41 in group 1 and 37/37 in group 2) Indeed in only one case did X ray changes occur after 6 weeks.

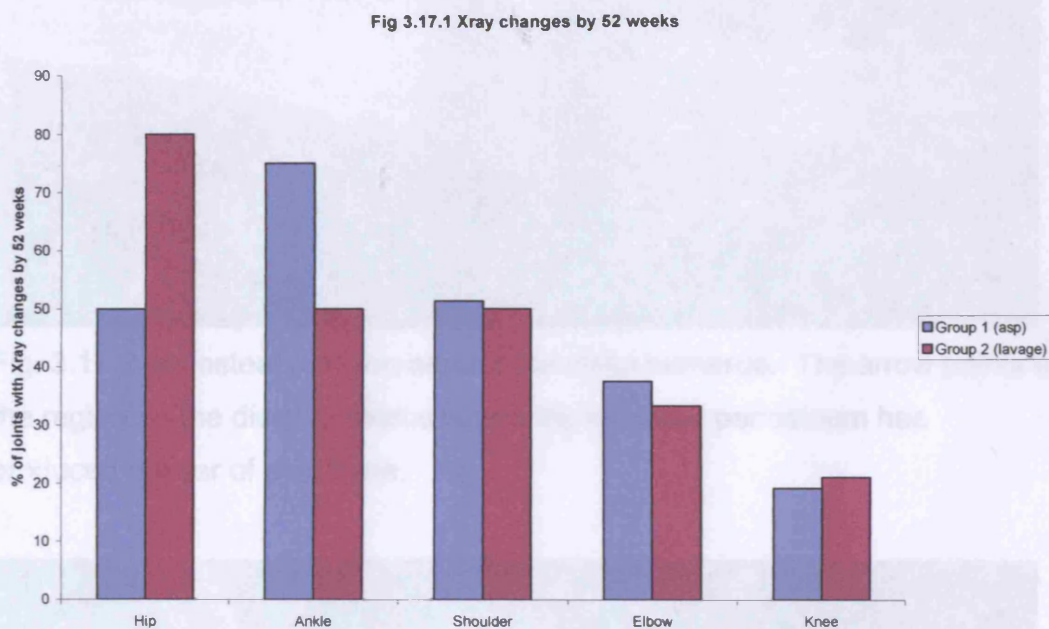
### 3.17.1 Delay in presentation and likelihood of X ray changes

It might be thought that patients who had had a longer delay before presenting for treatment would be more likely to have X ray changes because the joint had had a longer period without treatment for damage to occur. This could not be shown from these data as patients who had X ray changes by two weeks had a mean presentation delay of 7.0 days (sd 4.61) compared to patients with no X ray changes at 2 weeks who had a mean presentation delay of 6.4 days (sd 4.08). This shows a slightly longer delay in the patients with earlier X ray changes, but the difference is not statistically significant. ( $p=0.07$ , students t test).

### 3.17.2 X ray changes for individual joints

The number of X ray changes seen in individual joints are illustrated in fig 3.17.1. It is noted that in both groups X ray changes occur in 50% of cases or more for the shoulder, ankle and hip, but only in approximately 35% for the elbow and 20% for the knee.

Fig 3.17.1 Xray changes for individual joints by 52 weeks



Thus far only the number of X ray changes in the different joints has been compared to see if there is a difference between the two groups. The nature of the X ray changes seen in the individual joints will now be outlined and illustrated in the pictures that follow.

Fig 3.17.3 Periosteal elevation around the proximal tibia

### 3.17.3 X ray changes in the elbow

There were 4 X ray changes in a total of 11 elbows (36%). These comprised periosteal reaction in either the distal humerus or the proximal ulna, and in one case mild metaphyseal erosion in the proximal ulna.



Fig. 3.17.2 periosteal reaction around the distal humerus. The arrow points to the region on the distal humerus where the elevated periosteum has produced a layer of new bone.



Fig 3.17.3 Periosteal elevation around the proximal ulna



Fig 3.17.4 early metaphyseal erosion around proximal ulna



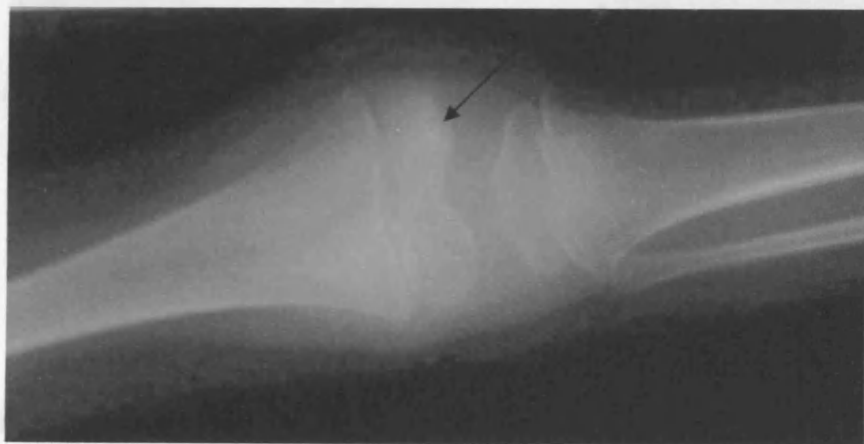
b  
Fig 3.17.5 a&b, Septic arthritis of the knee, examples of erosion of epiphysis

### 3.17.4 X ray changes in the knee

There were a total of 17 X ray changes in 85 knees (20%). These comprised mainly small irregularities in the femoral epiphysis, and periosteal reaction in the juxta-articular region of the distal femur. In one case there was significant proximal tibial metaphyseal erosion (fig 3.17.6) which settled, did not progress any further towards osteomyelitis, and did not affect clinical function.



a



b

Fig 3.17.5 a&b, Septic arthritis of the knee, examples of erosion of epiphysis



Fig 3.17.6 Example of proximal metaphyseal erosion in the tibia



Fig 3.17.7 Periosteal elevation on distal femur



### 3.17.5 X ray changes in the ankle

There were 12 X ray changes in 22 ankles (55%). These comprised mainly mild epiphyseal and metaphyseal erosions of the tibia, and some distal tibial periosteal reaction.



Fig 3.17.8 a&b Distal tibial metaphyseal erosion in septic arthritis of the ankle

Fig 3.17.10 Septic arthritis of the ankle with distal tibial periosteal elevation



Fig 3.17.9 Distal metaphyseal erosion with a cystic appearance



Fig 3.17.10 Septic arthritis of the ankle with distal tibial periosteal elevation

### 3.17.6 X ray changes in the hip

There were 7 X ray changes in 11 hips (64%). The hip was the joint where the most clinically significant X ray changes took place. The mildest changes were epiphyseal and metaphyseal erosions which did not progress, but in the two cases illustrated following they progressed to total loss of the femoral head. There were only 11 hips in the study and these catastrophic complications thus represent a joint destruction rate of approximately 20%. In both cases the sepsis had settled clinically and haematologically but the loss of a femoral head significantly reduced function, caused pain, and reduced the BSJS scores for the hips.

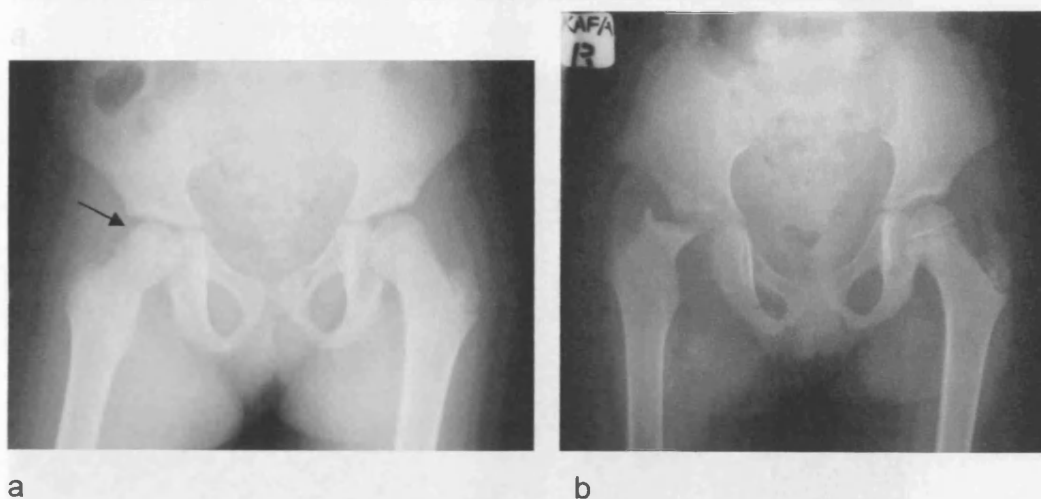
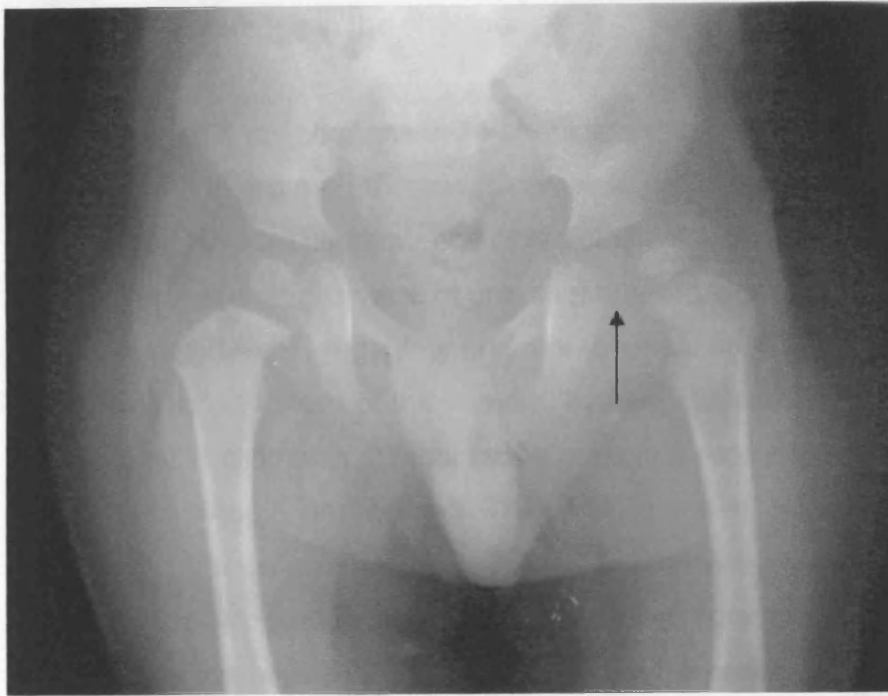


Fig 3.17.11a&b, Septic arthritis of the right hip, in the same patient, treated by arthrotomy and lavage. The X ray on the left (a) taken after two weeks showed erosion of the femoral and acetabular surfaces. There may also be some epiphyseal slippage as the growth plate is not clearly seen (arrowed). In the film on the right (b) taken at six weeks the femoral head is already lost.

Fig 3.17.12, Septic arthritis of the left hip treated by arthrotomy. In the X ray above (a) taken at 2 weeks there is some lateral subluxation giving a widened joint space (arrowed) and both metaphyseal and epiphyseal lucency. The patient was nursed in abduction but this did not prevent the loss of the femoral epiphysis seen in the film below (b) taken at six weeks.



a



b

Fig 3.17.12 Septic arthritis of the left hip treated by aspiration. In the X ray above (a) taken at 2 weeks there is some lateral subluxation giving a widened joint space (arrowed) and both metaphyseal and epiphyseal lucency. The patient was nursed in abduction but this did not prevent the loss of the femoral epiphysis seen in the film below (b) taken at six weeks.

### 3.17.7 X ray changes in the shoulder

There were 38 X ray changes in 74 shoulders (51%). In 14 of these (6 in group 1 and 8 in group 2) there was complete radiological loss of the proximal humeral epiphysis. The sequence of radiological findings was similar in all of these. The first changes were of proximal humeral periosteal reaction or elevation, epiphyseal irregularity and metaphyseal erosion. Then there was rapid progression to loss of the humeral head epiphysis. These changes took place while the child was in most cases making a recovery clinically, and function was virtually unimpaired. Thus it is likely that, although no humeral head could be seen on X ray, a cartilaginous remnant remained as a functional spacer. (Ultrasound and computerised tomography scans were later taken of this region in an attempt to show the cartilage spacer - see p 107) The study protocol ended at one year and no recalcification had occurred by then, however two cases were followed up for two years and both showed evidence of some recalcification albeit irregular.

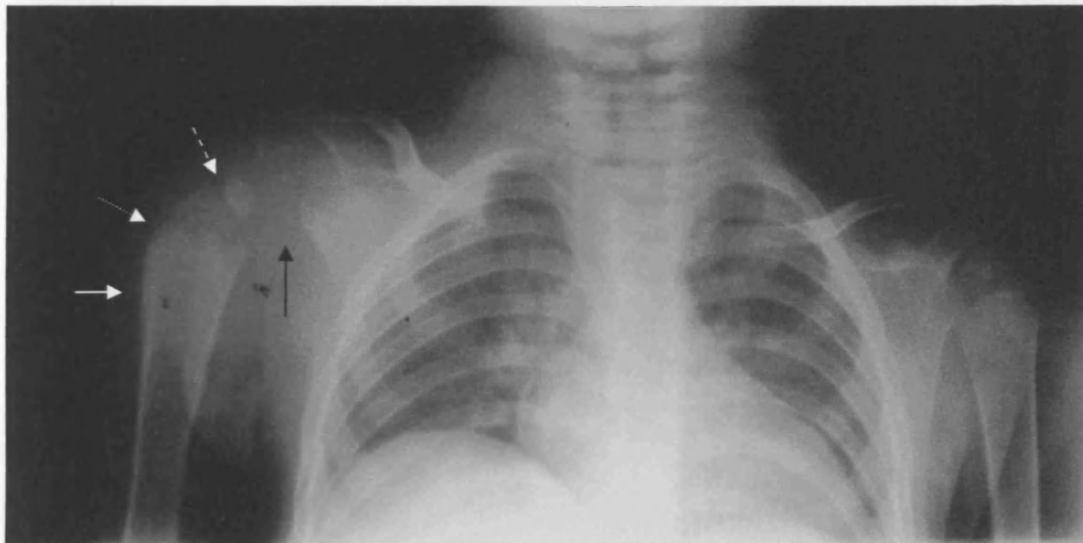


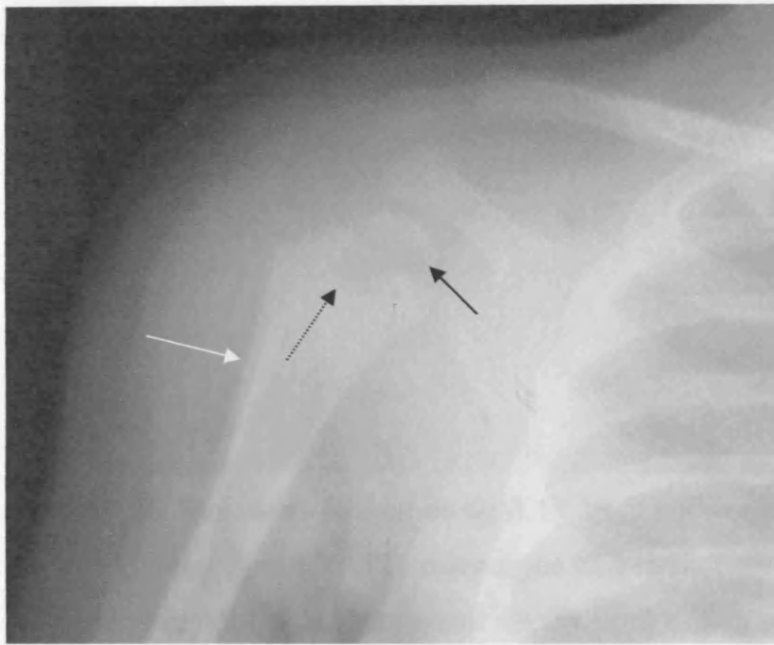
Fig 3.17.13 The typical early changes that were seen in septic shoulders. This X ray is taken 2 weeks after presentation and there is some proximal humeral periosteal elevation (solid white arrow), epiphyseal irregularity (dotted white arrow) and metaphyseal erosion (dashed white arrow) in the right shoulder. There is also widening of the joint space (black arrow) compared to the other side, representing early subluxation.



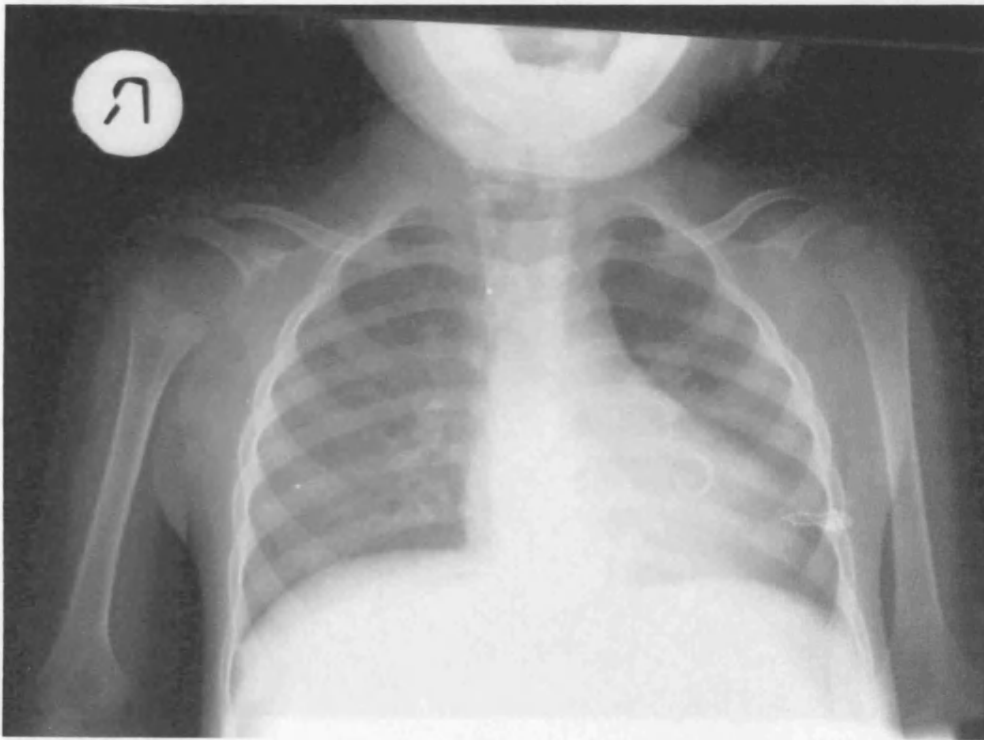
Fig 3.17.14 Septic shoulder, the same case as 3.17.12, seen at six weeks when the right proximal humeral epiphysis (on the left side in the picture) is no longer visible.



Fig 3.17.15 Septic shoulder, a further case where the top of the humerus at six weeks shows periosteal elevation (white arrow), epiphyseal irregularity (black arrow) and epiphyseal irregularity (solid black arrow). By ten weeks in the bottom X ray (b) the epiphysis is not visible as the humerus does not migrate proximally and function remains good.



a



a

Fig 3.17.15 Septic shoulder, a further case where the top X ray (a) taken at 2 weeks shows periosteal elevation (white arrow), metaphyseal erosion (dotted black arrow) and epiphyseal irregularity (solid black arrow). By six weeks in the bottom X ray (b) the epiphysis is not visible yet the humerus does not migrate proximally and function remains good.

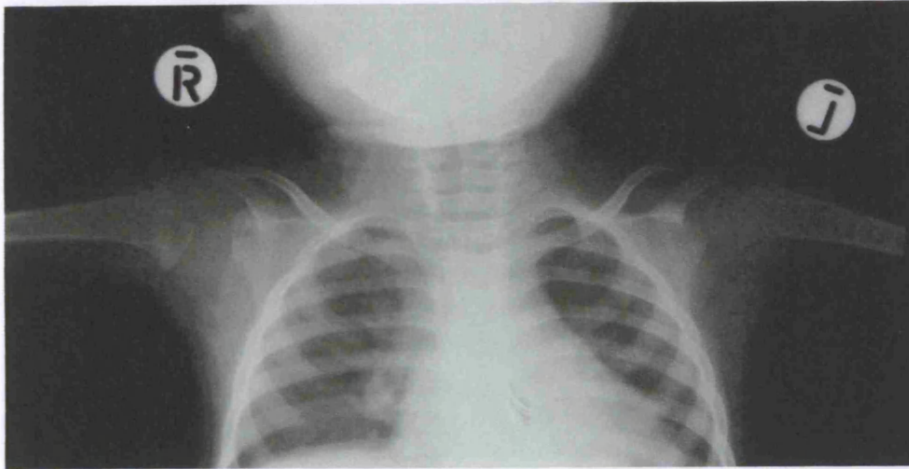


Fig 3.17.16 the same patient as fig 3.17.15 at six weeks showing abduction to 90 degrees. There is the appearance of a radiolucent humeral head spacer in the right shoulder (under the ® sign) acting as a fulcrum even though the ossification centre is not visible on X ray



Fig 3.17.17 the same patient at six weeks showing the good range of abduction movement achieved by a combination of glenohumeral and scapulothoracic movement. The right scapula (arrowed) is rotating and the tip is protruding laterally, nevertheless the patient was symptom free.





Fig 3.17.18 Ultrasound scan of the same patient in 3.17.15, showing the rounded edge of the presumably cartilaginous humeral head.  
 (This picture was taken using a 5 megahertz curvilinear probe on an Alkoha portable ultrasound machine.)

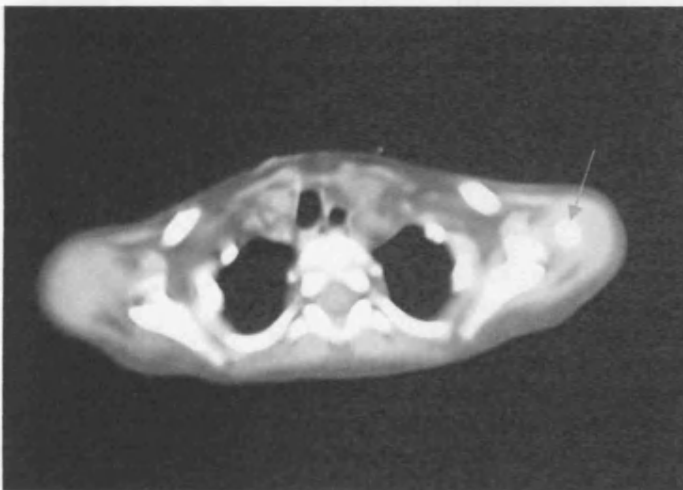


Fig 3.17.19 CT scan of the same patient at the level of the humeral head showing calcification in the left humeral head (grey arrow), but no calcification in the right humeral head (seen on the left in the picture). However there is tissue of the same radiodensity as cartilage.

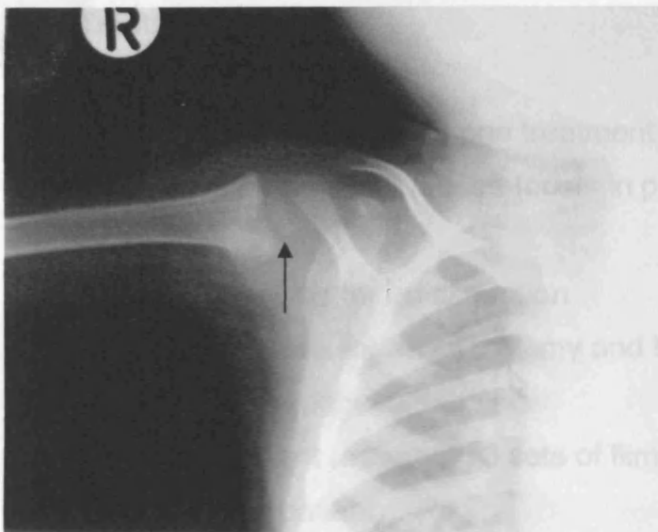


Fig 3.17.20 X ray of the same shoulder at 2 years showing return of calcification to the humeral head (arrowed)

#### Average cost per patient in group 1

Of the 108 patients in group 1, 6 needed arthroscopy because of initial aspiration failure, and 13 needed repeat aspiration.

The total cost of all the procedures was  $108 \times 20 + 6 \times 50 + 13 \times 20 = 5060$

The total laboratory costs were  $108 \times 5 = 540$

The total xray costs were  $108 \times 6 = 648$

The total antibiotic costs were  $108 \times 5 = 540$

The average length of stay was 7.1 days thus the total accommodation cost was  $7.1 \times 108 \times 3 = 2300.4$

The total expenditure in group 1 was  $5060 + 540 + 648 + 540 + 2300.4 = 9088.4$  and the cost per case is thus  $9088.4/108 = \underline{\underline{£84.15}}$

#### Average cost per patient in group 2

90 patients had an arthroscopy and 2 patients needed a second arthroscopy thus the cost of procedures was  $90 \times 50 = 4500$

the total laboratory costs were  $90 \times 5 = 450$

the total xray costs were  $96 \times 6 = 576$

The total antibiotic costs were  $96 \times 5 = 480$

### 3.18 Treatment Costs

In order to compare the costs of one treatment method against another the following estimates have been used (costs in pounds sterling):

Operating theatre costs for an aspiration	20
Operating theatre costs for an arthrotomy and lavage	50
Laboratory costs per patient	5
X ray costs per patient (assuming 3 sets of films per patient)	6
Antibiotic costs per patient	5
Accommodation in hospital for patient and one guardian for one night	3

#### Average cost per patient in group 1

Of the 108 patients in group 1, 6 needed arthrotomy because of initial aspiration failure, and 13 needed repeat aspiration.

The total cost of all the procedures was  $108 \times 20 + 6 \times 50 + 13 \times 20 = 5060$

The total laboratory costs were  $108 \times 5 = 540$

The total xray costs were  $108 \times 6 = 648$

The total antibiotic costs were  $108 \times 5 = 540$

The average length of stay was 7.1 days thus the total accommodation cost was  $7.1 \times 108 \times 3 = 2300.4$

The total expenditure in group 1 was  $5060 + 540 + 648 + 540 + 2300.4 = 9088.4$  and the cost per case is thus  $9088.4/108 = \underline{\underline{\pounds 84.15}}$

#### Average cost per patient in group 2

96 patients had an arthrotomy and 2 patients needed a second arthrotomy thus the cost of procedures was  $98 \times 50 = 4900$

the total laboratory costs were  $96 \times 5 = 480$

the total xray costs were  $96 \times 6 = 576$

The total antibiotic costs were  $96 \times 5 = 480$

The average length of stay was 8.7 days thus the total accommodation cost was  $96 \times 8.7 \times 3 = 2505.6$

The total expenditure in group 2 was  $4900 + 480 + 576 + 480 + 2505.6 = 8941.6$ , and the cost per case is thus  $8941.6/96 = \underline{\underline{£93.14}}$

The treatment costs per case for the two procedures is thus very similar at £84.15 for group 1 and £93.14 for group 2. The initial procedure cost for group 1 is much less than group 2, but this is mitigated by the fact that approximately 5% of patients in group 1 will need an arthrotomy, and 12% will need a repeat aspiration.

## Chapter 4 Discussion

### 4.1 Incidence of Septic Arthritis

The prospective incidence study in Chikwawa district suggests an incidence of septic arthritis of approximately 1/5000 per year for children under five, and 1/20000 per year for children over 5 but under 16 (para 3.1). If a child has a 1/5000 chance of developing septic arthritis each year that he or she is under 5, then by the age of 5 there will be a 1 in 1000 chance of having or having had septic arthritis. This is equivalent to the incidence of the common congenital abnormality club feet. Malawi has approximately 5 million children under 16, and if the incidence figures from Chikwawa are valid for the country then there will be an expected 570 new cases of septic arthritis in the five years and under age group in the country every year. It is likely that the Chikwawa figures are conservative so this represents a significant burden of pathology. When the study was started there was only one orthopaedic surgeon in the country thus there was a practical imperative to find an appropriate but effective treatment method for this common condition.

The incidence of septic arthritis in the West is not known exactly but it is clearly much less than in sub Saharan Africa. Why is the incidence in sub Saharan Africa so high? It might be thought initially that it was in some way related to the HIV epidemic that is occurring in the region, but this is unlikely as the HIV prevalence rate in our patients was only 8% (table 3.6), which is slightly less than the figure of 10% that Callaghan found in children admitted to QECH hospital for non infective conditions (16). Similarly the high incidence of septic arthritis might be thought to be due to sickle cell disease since this is known to be associated with *Salmonella* osteomyelitis. However there was no association in our study, and of 204 children only 6 were sickle positive (table 3.6). The most likely reason for the high incidence of septic arthritis in the region is that the children are underweight, probably under nourished, and anaemic, and thus susceptible to infection. It has been shown by other authors that immune responses are reduced in malnourished children (25). Our results show that the majority of the children in the study

were below the 50<sup>th</sup> centile for weight, and the mean haemoglobin for all the children on admission was under 9g/dl (table 3.2).

Other authors have found that there is a higher incidence of septic arthritis in the rainy season (79). In an interim publication of our results for septic shoulders we also found a tendency for this (109), but review of all our patients over the 21 months of collection did not show any convincing correlation with season (Table and fig 3.4).

The sex ratio for boys to girls was approximately 2:1 (Table 3.2). This is possibly explained by boys taking part in activities where they are more likely to traumatise their joints.

#### 4.2 Joints involved

The commonest joints involved in our patients were the knee and the shoulder (table 3.7.1 and fig 3.7). This distribution is similar to all other studies in the sub-Saharan region including the author's earlier work in Zambia (65). It has already been remarked that this situation contrasts markedly with that of septic arthritis series from the West, where the knee is the commonest joint and the hip second (33). The difference is largely due to the high incidence of shoulder infection, and the most plausible theory seems to be that in Malawi as in Zambia mothers lift their child onto the back by holding the child's elbow or humerus (fig 4.1 and 4.2). Western mothers almost never lift their children by the arm, indeed it is difficult to swing a well fed infant by holding the upper arm. If mothers are mainly right handed and face their children before swinging them onto their backs then it might be assumed that the child would be lifted by the left arm. Our results on the side of the joint infected did not show any difference between the sides with 101 left sided joints involved compared to 103 right sided joints. An observer in one of our follow up clinics watched all mothers who picked up their children and put them on to their backs. She found no pattern to which arm the mothers used nor which arm on the child they grab. Both appear to be

determined simply by where the child is when the mother wants to pick him or her up. This random method of picking up the child agrees with our findings in that no side has predominance in the pick up or incidence of septic arthritis.



Fig 4.1 Child in follow up clinic being lifted by mother – using the shoulder



Fig 4.2 Child in ward about to be lifted by his shoulder

The clear difference in mean ages for different joints ( Table 3.7.2 & Fig 3.7.2) was of interest, as such an analysis has not been made before in the literature. Our results show a mean age of 13 months for the shoulder, followed by 22 months for the elbow, 38 for the ankle, 39 for the knee and 84 for the hip. This predominance of upper limb infection in the young could again be explained by the above theory, as the upper limb is subject to most trauma in the early stages of life and the lower limb takes over as the child gets more adventurous and falls over more often. It would be interesting to make a comparison with a similar malnourished population in a country where mothers do not handle their children by the upper limbs.

#### 4.3 Infecting organisms

Initially it was disappointing that approximately 40% of our patients had pus in the joints but grew no organism. However this is a similar rate to other series in more developed countries (86) and may result from previous antibiotic use, or difficulties in making cultures. Our patients claimed no previous treatment, and this was a condition of entry to the study, but it is possible that well meaning relatives or traditional village healers had given antibiotics.

The big difference between Western and sub Saharan septic arthritis series, including this study, is the high prevalence of *Salmonella* as an infecting organism. *Salmonella* species were grown in approximately 30% of all joints in both groups taken as a whole. (Table 3.9.1 & fig 3.9.1) This is very likely to be related to the high incidence of *Salmonella* bacteraemia in this geographical region, as has already been shown by others (39, 40). *Salmonella* bacteraemia is common where malaria is endemic and diarrhoeal disease common. It is likely that where microtrauma occurs in the joints of malnourished children, an environment conducive to the development of septic arthritis is set up, and in sub Saharan Africa *Salmonella* is the commonest prevailing pathogenic organism that is in the bloodstream (39, 40).



When bacteriological spectra are compared for the different joints (figs 3.9.2 – 3.9.6), it is interesting to see that the main joint where *Salmonella* predominates is the shoulder. This is probably due to the fact that it is the joint that is predominantly affected in the youngest patients, and we know from other studies in this region that *Salmonella* bacteraemia is commonest in children between 10 and 14 months of age (39, 40).

In the knee and the elbow *Salmonella* was only marginally the commonest organism but both joints had a high 'no growth' rate in excess of 50% (table 3.9.2).

In the other joints of the lower limb, the hip and the ankle, *Salmonella* was not the most common organism. Here *Staph. aureus* predominated in the hip, and in the ankle there was a more mixed spectrum of causes including *Staph. aureus*, *Haemophilus influenzae*, and *Strep. pneumoniae*. (table 3.9.2)

It has long been known that *Salmonella* osteomyelitis is more common in patients with sickle cell disease (4). In our patients sickle cell disease was not a related factor as only 6 out of 204 patients were sickle positive. (Table 3.6)

#### 4.4 Clinical Features

Our study confirms what is already known about septic arthritis, that the most common features are fever, pain, swelling, loss of movement and loss of function. But a high index of suspicion should however be maintained in the absence of all these features as not all patients mount a full inflammatory response. Some patients, possibly the sickest, have little pain and inflammation, and a minimally raised ESR (65).

#### 4.5 Time of presentation

It has been mentioned in the literature review that early treatment of septic arthritis is associated with better results and that there are theoretical reasons for trying to treat patients within the first few hours of infection (108). It was therefore disappointing to see that our patients presented on average almost a week after the first symptoms (Table 3.5). Malawi has a poor primary health care system, and very few patients present early to a hospital with any condition, so septic arthritis is not alone here. In the West, parents may take a child with a painful joint to their primary care physician, or to a hospital on the day of presentation, but in Malawi to attend a hospital often involves a family conference and a long journey, taking supplies of food and money. Thus it is unlikely that in the near future patients with septic arthritis will present significantly earlier.

#### 4.6 Follow up

Before discussing follow up results a comment should be made on the fact that all patients who were offered to take part in the study accepted. There was no coercion on the part of the author or his registrar and it was carefully explained that the same standard of treatment would be offered whether or not the patients were in the study. However it appeared that the mothers of children in the study formed a cohesive group who were together in the ward and met regularly at the follow up clinics, appreciated the care that they were given, and probably allayed any fears of future recruits to the study.

Follow up for any study is difficult in a country where the majority of patients do not have a general practitioner, a telephone, or even a written address. When a patient entered the study we obtained as much information about where they lived as the parent or guardian could give us, including a list of people to ask in the vicinity of their village if we could not find them. Our early follow up results were excellent with 100% of patients being seen at 2 weeks and 6 weeks, and 95% at 12 weeks (table 3.3). From the point of view of

outcomes 12 weeks was a reasonable time to assess patients as very few clinical or radiological deteriorations or improvements occurred after this time. By 24 weeks the follow up rate had dropped to 65%. This is likely to be partly due to the fact that so many of the patients were well and symptom free at this stage. Indeed the BSJS scores hardly change for most joints between the 6<sup>th</sup> and the 52<sup>nd</sup> week (Table 3.13 and Figs 3.13.1 to 3.13.6). By 24 weeks we also had evidence that 9 of our patients had died from causes unrelated to their joints. It is very likely that more patients had died as the average under five mortality rate in Malawi is around 20%, and our patients were probably in the less healthy sections of the community. However this is conjecture as we do not have firm figures. It was hard to see while we were doing the study how follow up could have been improved in the later stages, as we did all we could to find patients, and had many hours of driving around muddy villages. One suggestion for future studies is to use a Global Positioning Satellite (GPS) localising device and to take each patient home after discharge, then to log their exact home coordinates and record them in the notes.

#### 4.7 Radiological changes

The radiological changes seen have already been outlined in chapter 3. The high percentage of radiological changes in shoulders (51%) and hips (64%) may well be explained by these two joints having completely intra-articular epiphyses. This may also explain the large number of hip and shoulder epiphyses that were destroyed. The route of entry of infection to joints such as the hip and shoulder where there is an intra-articular metaphysis, could be blood borne via the synovium, but could also be transmission via the metaphysis. Early infection in the humerus or femur could decompress into the joint before any X ray changes in the bone are detected. This is a very difficult hypothesis to test but in practice does not change management. It does reinforce the argument for continuing antibiotics in septic arthritis for at least six weeks as in these joints there is a blurred junction between osteomyelitis and septic arthritis. Each may be the progenitor or the complication of the other.

Two of the septic shoulders where there was complete destruction of the humeral head ossification centre were followed up on an annual basis for 2 years beyond the study protocol of one year. It is interesting that in both of them the ossification centre reappeared, although it was deformed (fig 3.17.20). In an attempt to explain the pathophysiology, it is likely that the initial ossification centre was destroyed by the infection but that not all the cartilage surrounding it was destroyed. This remaining cartilage retained the potential for ossification, and the formation of an albeit deformed humeral head.

#### 4.8 Aspiration versus washout

The question as to whether aspiration is as effective as open arthrotomy and washout in the removal of pus in septic arthritis was the main reason for performing this prospective randomised study. Our null hypothesis was that there was no difference between the two methods. The literature review section of this thesis has highlighted the paucity of prospective studies on methods of removing pus from a joint. There is a consensus among published authors that pus should be removed from septic joints but clinicians differ on how it is best removed. Those who favour surgical removal support their position with the argument that pus is a potent source and promoter of proteolytic enzymes (20, 21), and that every particle of pus should be removed from the joint.

However those who favour aspiration have on their side the relative ease, and lower cost of the procedure, and its established position as a treatment that has stood the test of time. In a developing country like Malawi where resources are limited, aspiration has the advantage that it can be carried out almost anywhere, and does not need a fully equipped operating theatre. Indeed arthrotomy in a partially equipped or less than clean theatre may carry significant extra risks, both of an inadequate procedure and of secondary infection.

This study looked at the two methods of pus removal in a comprehensive and prospective way. The results demonstrate that aspiration failed to remove any pus in 6 out of 108 (5.6%) cases where pus was definitely there (Table 3.10). It failed completely in these cases, and the back up of arthrotomy was needed. There were a higher percentage of failures in the hip and the ankle but failures were also recorded in the relatively superficial joints such as the knee. Aspiration also needed repeating because of reaccumulation in 13 out of 108 cases (12.0%) compared to arthrotomy which needed repeating in only 2 out of 96 cases (2%) (Table 3.10). It is likely that aspiration, even when it works, leaves a significant amount of pus in the joint. Aspiration is thus a less invasive, but also less efficient way of removing pus. However despite failing completely in 5.5% of cases, and needing repeating in 12.0% of cases, aspiration is successful in removing at least some pus in 94% of cases, and when it works, the patient's rate of recovery is significantly faster, measured in terms of the time it takes to reach the discharge criteria of being afebrile, non tender, having reduced swelling, and actively using the joint. Patients in the aspirated group reached the discharge criteria in a significantly lower mean of 7.1 days compared to 8.7 days in the arthrotomy group (table 3.12). This faster recovery may be related to the lower degree of surgical trauma inflicted by needle prick aspiration compared to a 3cm arthrotomy, dividing skin, intervening structures, joint capsule and synovium.

The aspirated group reached the discharge criteria earlier, but from then onwards there was no significant difference in clinical or haematological results between the two groups.

The clinical comparison between the two groups was done using the author's independently verified scoring method, the Blantyre Septic Joint Score (BSJS) (110). This measures a combination of swelling, tenderness, range of motion and function. Comparative BSJS scores showed that the arthrotomy and lavage group, (group 2) as a whole entered the study with a slightly worse clinical score than the aspiration group (group 1). The mean BSJ score for group 1 was 7.23 compared to 6.57 for group 2. This difference was significant when analysed by the ttest, however to put this into perspective the

score for a normal joint is 16, so the mean difference between the presenting scores for groups 1 and 2 is only 0.66/16 (or 4% of a normal score). From a scientific point of view it was disappointing to find such a difference between the two groups before treatment. No obvious logistical cause for this could be found, but it was noted that there was an unequal split of the six knee cases that presented with a BSJ score of 10 and over, and this certainly contributed to the difference between the groups. However despite this small initial difference between the groups at presentation, there was no significant difference in clinical outcome between groups at any stage from 2 weeks to 52 weeks (table 3.13).

Table 3.13 was calculated using only the 102 patients in group 1 for whom aspiration was successful in removing pus. It did not include the 6 /108 cases where aspiration failed. Another way of considering the same data is to use an 'intention to treat' analysis. This is essentially the assessment of what would happen if a policy of aspiration of all septic joints was carried out. This has been done in table 3.13a, but because there were so few failures it does not change the overall results.

It can be seen graphically from figs 3.13.1 to 3.13.6 that both groups showed a similar pattern of clinical improvement with the majority of change happening in the first two weeks, then a smaller degree of improvement between two and six weeks leading to an almost normal BSJ score, then minimal improvement after six weeks. Thus one can on clinical grounds defend both treatment methods as effective, but with the available evidence one cannot say in clinical terms that one method is better than the other.

The haematological variables measured were haemoglobin concentration, white cell count and erythrocyte sedimentation rate (ESR). Haemoglobin concentration showed a steady increase from a mean of below 9g/dl in both groups to a level above 10g/dl in both groups (table 3.14). There was no significant difference between the groups.

White cell count in both groups fell from means of approximately 14,000/ml to approximately 9,000/ml in both groups. There was no significant difference in the rate of decrease between the two groups (table 3.15)

ESR also fell in both groups from a mean of approximately 60 to 35. Again there was no significant difference between the two groups (table 3.16).

Radiological examination of both groups again showed no difference between aspiration and lavage (Table 3.17). It was salutary that almost 40% of all joints developed some X ray changes, albeit minor, and these changes may signify a mild degree of concurrent osteomyelitis. But despite these X ray findings the majority of patients still had excellent clinical results. It should also be noted that where X ray changes were going to occur, most of them had started by two weeks and in all but one case had appeared by 6 weeks. This gives weight to the common practice of giving antibiotics for 6 weeks.

It may be argued that all our cases presented late, at about 7 days after the start of symptoms, and that some degree of established infection or osteomyelitis was to be expected. It is possible that this explains the fact that so many of each group developed some degree of radiological changes. It may also be argued that removing pus one week after the start of symptoms is too late for an early recovery, and that is why there is no clinical difference between the two methods of pus removal. In an ideal world one would like to treat septic arthritis on the day it presents, or even the hour it presents. However the world is not ideal, there are many constraints against early presentation in Malawi and the clinical picture here is probably always going to be one of late presentation. There is also a practical relevance in a scientific study of treatment dealing with the pathology as it presents, rather than as it does not present. This study is therefore looking not at an ideal situation but a real one.

In this realistic situation therefore, this study has shown that aspiration will fail in around 6% of cases, and even where it succeeds it has a 12% chance of needing to be repeated. When aspiration is successful in removing pus, the

clinical haematological and radiological results at up to one year are similar to those after arthrotomy and lavage. Patients leave hospital a mean of 1.6 days earlier after aspiration (table 3.12), but apart from this one area, the null hypothesis that there is no difference in outcome between the two treatment methods has not been disproved, and this study has not shown that one method of pus removal is better than the other. Both methods give good results in the short and long term, and in clinical situations where both are options, both can be defended by clinicians. In our institution, where both surgeons and time in theatre are at a premium, as a result of this study, we have chosen a policy of immediate aspiration of septic joints. Where aspiration fails to remove pus or where there is difficulty, we have a low threshold for open arthrotomy.



## Chapter 5 Conclusions

- Septic arthritis is common in Malawian children, with an annual incidence of at least 1 in 5000 in children aged one to five. Thus by the age of five a child will have a greater than 1 in 1000 chance of having had septic arthritis.
- Children with septic arthritis in Malawi present to hospital late, an average of 7 days after the onset of symptoms.
- Children with septic arthritis are underweight, with a mean weight of less than the 50<sup>th</sup> centile for their age. They are also anaemic with a mean haemoglobin of less than 9g/dl.
- The commonest joints involved are the shoulder and the knee, with a clear age spectrum. Upper limb septic arthritis is found in younger patients than lower limb septic arthritis. The mean age for patients with septic arthritis of the shoulder is 13 months, for the elbow 22 months, the ankle 38 months, the knee 39 months and the hip 84 months.
- The commonest organism responsible for septic arthritis is *Salmonella*, especially in the upper limb. The bacterial spectrum is more mixed in the lower limb and in the hip *Staph. aureus* is the main cause.
- Aspiration as a method of removing pus was unsuccessful in almost 6% of cases, with the hip being particularly difficult, and where successful it needed repeating in 12% of cases because of reaccumulation. A properly performed arthrotomy and lavage was never unsuccessful and only needed repeating in 2% of cases.

- Aspiration is a more benign procedure, and if successful in removing pus patients recover marginally faster in the first week, leaving hospital at a mean of 1.7 days earlier than patients who have had an arthrotomy.
- From two weeks onwards there is no clinical radiological or haematological difference between treatment by aspiration or arthrotomy and lavage.
- Outcome after treatment by arthrotomy or lavage and six weeks of appropriate antibiotics is good, with no significant radiological abnormality in most cases of infection of knee, ankle or elbow. Shoulder sepsis has a 30% chance of resulting in at least temporary loss of the proximal humeral epiphysis but good clinical function. Outcome after hip sepsis with either treatment modality appears to be more complicated with a 20% loss of proximal femoral epiphysis in our small series.
- **In our institution we have looked at the results of this study and the relative costs involved for each case. We have also considered that fact that we are a training institution and some of the trainees will work in hospitals where there is no functioning operating theatre. Our aim for the treatment of many common conditions is to develop evidence based guidelines, and our guideline for septic arthritis is to attempt aspiration with a wide gauge needle as early as possible, but to have a low threshold for arthrotomy should there be any difficulty.**

## Chapter 6 Recommendations for further study

This thesis reports on the largest prospective study so far on septic arthritis in sub Saharan Africa. Its conclusions have been outlined above. Having finished the study it is clear that there are other areas of understanding about the natural history and treatment of septic arthritis that would benefit from further study, but are beyond the scope of this thesis. These include the following:

1. An incidence study covering a larger area, or sampling from different geographical and socioeconomic areas in Malawi and in the region. This would give a clearer idea of the burden of disease caused by septic arthritis
2. A study to assess the length of time antibiotics need to be given. The sustained reduction in ESR, white cell count, and the improved function in most cases, as well as the lack of new X ray changes after six weeks lead us to assume that six weeks of antibiotics is sufficient, but it may be that a shorter period of time is as efficient, as many children were clinically well at two weeks.
3. A study involving other methods of removing pus such as arthroscopy and tidal irrigation.
4. A study comparing the same treatment methods, ie aspiration and arthrotomy with lavage, but in a population that presents earlier. It is possible that our failure to disprove the null hypothesis was because our patients presented almost a week after the symptoms and that removal of pus at that stage was too late.
5. Long term follow up studies of children who have had septic arthritis, particularly in the shoulder, to see the long term effects of reossification of the humeral head epiphysis, and whether it grows normally.

6. A study of upper limb and especially shoulder infections in a country where there is a similarly malnourished and anaemic population, but where mothers do not lift children by the arm. It may be that shoulder sepsis will be less common.

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<http://www.nso.malawi.net>

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**Appendix 1**

**Copy of ethical permission from University of  
Malawi College of Medicine's Research and  
Ethical Committee**



UNIVERSITY OF MALAWI

*Department of Obstetrics and Gynaecology*

College of Medicine

Ref No. MC/COMRC.P.98/99/22

February 9, 1999

Dr Christopher B.D. Lavy  
Department of Surgery  
College of Medicine

Dear Dr Lavy,

**APPROVAL NO. COMRC.P.98/99/22**  
**OF JANUARY 27, 1999 - SEPTIC ARTHRITIS IN CHILDREN**

Your resubmitted proposal titled "A case study of needle aspiration vs washout in treatment of septic arthritis in children, was discussed at the COMRC's last meeting held on Wednesday, January 27, 1999.

I am pleased to inform you that the Committee approved the proposed research study.

You may now start making arrangements to commence your research work. However let me draw your attention to the follow requisites.

1. You inform the COMRC when you intend to start the work. When it starts, you should also inform us accordingly.
2. Before you start the work you arrange to submit the 10% administrative contribution of sum of US643.00 (US dollars six hundred and forty three) or equivalent in MK based on the prevailing exchange rate at the time of doing so, to the COMRC - Secretariat for record purposes, after which it will be forwarded for banking. The cheque should be in the name of the College of Medicine.
3. You submit regular (quarterly) progress reports to the COMRC - Secretariat - starting from the time the research project commences. This should be - three copies.
4. You submit four copies of your final research report, any papers to be presented at conferences, workshops, seminars or published in journals based on the results of this work to the COMRC - Secretariat who will submit the required copies to the NHSRC, URPC, and COM Library.

- 2 -

If you have any queries, please do not hesitate to contact the undersigned.

In all your future correspondence please quote the above approval reference number.

On behalf of the COMRC I wish you all the best in your work.

Yours sincerely,

**Secretary - COMRC**

cc : - Members of the COMRC  
- The Head - Surgery Dept  
- The Finance Officer - COM

VML/epm



## SEPTIC ARTHRITIS STUDY

### CONSENT FORM

Your child has septic arthritis which is a serious infection of the joint. If it is not treated properly it can result in permanent pain and loss of movement. There are currently two ways of treating this condition. One involves removal of the pus with a thick needle and the other involves removal of the pus using a small incision. Both methods of treatment are good and both methods are currently used in this hospital. We do not however know which method is best and we would like to compare the methods. If you agree to your child helping with this study then he/she will have one of the two procedures and will be closely followed up to ensure that he/she makes as good a recovery as possible. We will need to see your child at least four times in the outpatient department after discharge but will pay for your transport and for any drugs during the study.

If you do not wish to take part in the study you are free to refuse, and your child will continue to be looked after by the hospital staff. If you agree to helping with the study you are still free to withdraw at any time.

I agree to the above conditions.

Signed ..... Relationship to child.....

Witness.....

Date.....



**KAFUKUFUKU WA MATENDA OTUKUSIRA MOKUMANA**  
**MAFUPA (NYAMAKAZI)**

**PEPALA LA MGWIRIZANO**

Mwana wanu ali ndi matenda otukusira mokumana mafupa (Joints) yomwe ndi nthenda yoopsa kwambiri. Ngati sichizidwa bwino ingapangitse ululu wosatha ndikuumsa mokumana mafupamo. Pali njira ziwiri zochizira matendawa. Njira yoyamba ndikugwiritsa ntchito jakiseni wamkulu pochotsa mafinya, pomwe njira yachiwiri ndiyong'amba pang'ono ndikuchotsa mafinya. Njira ziwirizi ndizabwino ndipo zonsezi zikugwiritsidwa ntchito pachipatala pano. Panopo sitikudziwa kuti ndi njira iti yomwe ili yopambana imzake chomcho tikufuna kuti tifufuze njirazi. Ngati mukovomereza kuti mwana wanu athandize nawo kafukufukuyu, iye adzachizidwa potsatira njira imodzi mwa ziwirizi ndipo adzayang'aniridwa mpaka atachira bwinobwino. Tidzafuna kuti timuone mwana wanu kanayi ku Outpatient Department (kumbali ya odwala oyendera) mutatulutsidwa m'chipatala ndipo tidzapereka ndalama za ulendo wanu ndi mankhwala onse panthawi yakafukufukuyi.

Ngati simukufuna kutenga nawo mbali pa kafukufukuyu muli oloedwa kutero, ndipo mwana wanu adzapitiriza kupatsidwa chithandizo ndi ogwira ntchito pachipatalachi. Ngati mwafuna kuthandiza kafukufukuyu mulinso oloedwa kusiya nthawi iliyonse.

Ndikugwirizana ndi mfundo zili pamwambazi.

Dzina..... Chibale ndi Mwana.....

Mboni.....

Tsiku.....



**SEPTIC ARTHRITIS STUDY**

SAC52

Name.....  
 Date of birth..... 29  
 Address..... Chigumula Market. (Mandafakes (Tsope))  
 Tsope house. sells tobacco  
 telephone.....

Other Contact person.....  
 Address.....  
 telephone.....

Date of admission (day 0)..... 13.01.00  
 Joints involved..... Rt Shoulder swelling  
 Start of symptoms..... 5 days

Relevant History.....  
 (R) shoulder swelling / no trauma  
 fever headache

current malaria? y/n (n) MB region  
 last attack of malaria..... 3m ago

Clinical findings on admission:

Joint Range of movement	[2]	1 = nil	2 = restricted	3 = almost full	4 = full
Joint Swelling	[1]	1 = gross	2 = mild	3 = minimal	4 = none
Joint tenderness	[2]	1 = marked	2 = mild	3 = minimal	4 = none
Joint Function	[1]	1 = none	2 = some	3 = almost full	4 = full

Other areas of sepsis y/n (specify where) impetigo scalp abscesses (micro)

Spleen palpable y/n  
 Lymph nodes y/n (specify where) groin / axilla  
 arm circumference

Other examination findings NO oral thrush

Date of surgery..... 13.01.00 aspiration / washout

Surgery details if washout  
 incision: 2cm  
 Findings: Pus  
 Closure: suture

Joint fluid culture..... Sal. ententidis (S. ententidis)  
 Blood Culture..... NG 2d (no growth at 7 days)  
 Sickle test..... Negative

Inpatient data:

(copies of temp and drug chart attached)

FA052

Date	Day	Hb	WBC	% Poly	% Lt	esr	Wt/ kg	joint ROM	joint tend	joint swe	joint funcn	Temp	Xray
13/01	0	8.7	7.4	23	73	24	12.1	2	1	2	1	38°	✓
14	1							2	1	2	1	37 <sup>2</sup>	
15	2							3	2	3	2	37 <sup>2</sup>	
16	3							3	2	3	2	36 <sup>8</sup>	
17	4							3	2	3	2	37	
18	5							3	3	4	2	36 <sup>8</sup>	
19	6							3	3	4	3	37 <sup>1</sup>	
20/1	7	8.4	9.3	21	69	16	12.1	4	4	4	4	36 <sup>7</sup>	
21	8												
22	9												
23	10												
24	11												
25	12												
26	13												
27/01	14												
	15												
	16												
	17												
	18												
	19												
	20												
	21												

Drugs used. with date started and changes: Chloramphenicol 13.1.00

Outpatient data:

Date	time	Hb	WBC	% Poly	% Lt	esr	Wt/ kg	joint ROM	joint tend	joint swel	joint funcn	temp	x ray	pd
27/01	2wks	7.9	11.6	43	51	12	12.8	4	4	4	4		✓	60
24/02	6wks	8.4	9.3	53	40	8	13.1	4	4	4	4		✓	65
14/4	3mths	8.8	9.4	48	39	14	13.3	4	4	4	4		✓	65
14/7	6mths	8.7	8.7	51	38	10	14.0	4	4	4	4		✓	75
13/11	12m	9.1	7.5	40	39	12	14.3	4	4	4	4		✓	75

Comments