We present a retrospective review of 167 patients aged 18 years and under who were treated for chronic haematogenous osteomyelitis at our elective orthopaedic hospital in Malawi over a period of four years. The median age at presentation was eight years (1 to 18). There were 239 hospital admissions for treatment during the period of the study. In 117 patients one admission was necessary, in 35 two, and in 15 more than two.

A surgical strategy of infection control followed by reconstruction and stabilisation was employed, based on the Beit CURE radiological classification of chronic haematogenous osteomyelitis as a guide to treatment. At a minimum follow-up of one year after the end of the study none of the patients had returned to our hospital with recurrent infection.

A total of 350 operations were performed on the 167 patients. This represented 6.7% of all children’s operations performed in our hospital during this period. One operation only was required in 110 patients and none required more than three. Below-knee amputation was performed in two patients with chronic calcaneal osteomyelitis as the best surgical option for function. The most common organism cultured from operative specimens was Staphylococcus aureus, and the tibia was the bone most commonly affected. Polyostotic osteomyelitis occurred in four patients. We believe this is the largest reported series of patients treated for chronic haematogenous osteomyelitis.

Chronic haematogenous osteomyelitis may be defined as an infection in bone, originally derived from a bacteraemia or septicaemia, and lasting for three or more months. It is associated with long-term problems such as pain, chronic sinuses and exposed bone (Fig. 1), loss of the structural integrity of a limb (Fig. 2), deformity, joint stiffness and growth problems, and can be very difficult to treat. It is now rare in the developed world but remains common in more impoverished nations, particularly in children; 88% of the world’s children live in developing countries.

Malawi is a landlocked African country classified by the United Nations as one of the ‘least developed’. The population is just over 13 million, half of whom are children. Our institution is located in Malawi’s largest city, Blantyre, which is in the south of the country. It opened in 2002 and provides elective orthopaedic care for children free of charge.

We present a retrospective review of our experience in managing a series of children with chronic haematogenous osteomyelitis who were treated over a period of four years. To our knowledge this is the largest published series of children with chronic haematogenous osteomyelitis.

Patients and Methods
We identified all children aged 18 and under with a diagnosis of chronic haematogenous osteomyelitis who were admitted between 1 January 2003 and 31 December 2007 by searching the electronic database of admissions and the electronic theatre database. The medical and operation records, microbiology results and radiographs were all reviewed. Details of any further admissions of these patients were also reviewed until 31 December 2008, to include a period of follow-up of at least one year.

Our surgical strategy for the management of these patients employs a radiological classification system (Fig. 3) as a guide to treatment. Eradication of infection is achieved by removal of all dead tissue. Correction of any deformity is then undertaken with reconstruction of structural defects, followed by rehabilitation to restore function.

In patients where the involucrum was structurally inadequate, a temporising infection control procedure was used until it became structurally adequate. Surgery to eradicate infection was then completed. If the involucrum was poor at presentation and failed to...
In patients who had sclerosis as a component of their osteomyelitis (Fig. 3, Types B3 and C), oral flucloxacillin 50 mg/kg/24 h in four divided doses, for a total of six weeks according to age, was used routinely. The role of antibiotics in B2 and B4 types (Fig. 3) remains debatable, but it was our normal practice at the time of the study to use oral antibiotics for six weeks following sequestrectomy.

The aims of this retrospective study were to define the population of children requiring surgery for chronic haematogenous osteomyelitis in terms of patient demographics, the bones involved and the microbiology of the causative organism, to analyse the types and frequency of surgery required and to calculate the burden on the health care system in terms of the number of operations, hospital stay and the proportion of the case load.

The data were analysed by an independent orthopaedic surgeon (VLLB) not involved in the clinical care or surgery of this cohort of patients.

Results
During this period, 167 children with chronic haematogenous osteomyelitis were treated. The main outcome measure was whether any further in-patient management was recorded during a minimum period of follow-up of one year. The median age at presentation was eight years (1 to 18). There were 102 males and 65 females. The most common bones affected were the tibia (79 patients, 48.4%), the femur (47 patients, 29%) and the humerus (18 patients, 11%) (Fig. 4). There were four patients with polyostotic chronic osteomyelitis. The microbiology records of 94 (56%) patients were available (Fig. 5). The most common organism obtained from operative specimens was *Staphylococcus aureus* in 57 (61%) patients. No growth was found in 27 (29%).

There was a total of 239 admissions; 117 patients (72.5%) had one admission, 35 (19.7%) two admissions and 15 (7.8%) more than two (Fig. 6). The median length of stay for the first admission was 18 days (0 to 251) and for subsequent admissions ten days (0 to 124). These admissions accounted for 7.6% of all in-patient days at our hospital during the period of study.

A total of 350 operations were performed on the 167 patients, with a maximum of three per admission. However, 110 patients (67%) required only one operation. These 350 operations represented 6.7% of the 5235 performed during the study period.

Based on our surgical strategy, the operations were usually a combination of procedures such as eradication of infection and stabilisation, followed by reconstruction of soft-tissue and bone (Table 1). The two amputations were performed below the knee in two of the five patients with chronic haematogenous osteomyelitis of the calcaneum and were carried out during their first admission.

Control of infection was the main aim of surgery during the first admission (Fig. 7). In 50 patients (30%) who required more than one admission, 13 (8% of the total 167) had reconstruction and stabilisation. The nature and frequency develop, which was normally apparent within six months of the disease,16 all necrotic bone and tissue was removed and the limb stabilised either with a splint or an external fixator to facilitate eradication of the infection. Limb reconstruction was subsequently performed once the condition of the soft tissues was satisfactory.
of bony and soft-tissue reconstruction surgery is shown in Tables II and III. Of the original 167 patients, 27 (16%) required a second admission for surgery to control infection.

**Discussion**

We believe this to be the largest homogeneous series of children with chronic haematogenous osteomyelitis which has been published. The series described by Daoud and
Saighi-Bouaouina contains 34 patients and that of Cho et al. 31 patients with a minimum follow-up of three years. Although other series have described the treatment of 50, 67 and 107 patients with chronic osteomyelitis respectively, these reports contained a mixture of either traumatic or post-operative infection and included both children and adults. A study from Namibia reviewed 55 children with haematogenous osteomyelitis, but only 55% had chronic osteomyelitis. The remaining 45% had acute and subacute osteomyelitis.

In this series, as in others, the most commonly affected bone was the tibia, followed by the femur and humerus. There were five patients with chronic calcaneal haematogenous osteomyelitis. Two had severe disease and underwent below-knee amputations, as it was felt that this would provide them with a better functional outcome. To our knowledge, no other studies have reported the need for amputation. Recently, other authors have described the successful use of the split heel approach in the management of three patients with planatar chronic calcaneal osteomyelitis with a minimum follow-up of three years. A case report records an atypical mycobacterium causing chronic calcaneal osteomyelitis.

There were four patients with polyostotic disease, which has also been noted by Alonge et al. There were no common features among these patients, and at a minimum follow-up of one year, none had required further hospital treatment.

Staphylococcus aureus was the most common organism cultured from the surgical specimens, as has been
found in other studies of osteomyelitis from both the developing\textsuperscript{1,6,11,15} and the developed world.\textsuperscript{16} As with other series\textsuperscript{11} Escherichia coli and Proteus organisms were also cultured from the surgical specimens. Bacillus subtilis was cultured in 1\% of cases (Fig. 5).

It was not our routine practice during the study period to test patients for HIV infection. However, based on a previous paper by Lavy et al\textsuperscript{17} from Malawi in 2002, we estimate the prevalence of HIV in our patients to be no higher than 8\%. In 2005, the United States Agency for International Development reported that there were 91 000 children living with HIV in Malawi.\textsuperscript{18}

There were two patients who stayed in hospital for less than 24 hours, accounting for a ‘0 day’ length of stay. Both lived locally and were treated as day cases and were discharged on the day of admission. Of our patients 50 (30\%) had two or more admissions, mainly for infection control (16\%) or reconstructive surgery (8\%) (Fig. 6). Daoud and Saighi-Bouaouina\textsuperscript{1} also observed the need for multiple operations.

The successful use of antibiotic-loaded spacers during surgery to control infection\textsuperscript{7,8,14,19-22} was used in eight of our patients. Cho et al\textsuperscript{7} found the need for repeated curettage and/or bone grafting in reconstructive surgery in 32\% of patients following primary saucerisation and the use of antibiotic spacers. A study from Nigeria observed recurrent infection in 8.6\% of patients following treatment with antibiotic spacers.\textsuperscript{14}

We treated six patients by free fibular grafts and in one a second graft was necessary. The technique of tibialisation of the ipsilateral fibula\textsuperscript{23,24} was used in five patients. Callus distraction\textsuperscript{25} with both monolateral in three and circular frame fixation in five was used to reconstruct the tibia (Table II).

Although free gracilis muscle transfer has been used for the treatment of fistulae in chronic osteomyelitis of the tibia\textsuperscript{26} and to reconstruct soft-tissue defects, it was our practice to allow wounds to granulate after eradication of infection. In eight patients we performed split-skin grafts, and in one with type B4 chronic tibial osteomyelitis a local fasciocutaneous flap was used after successful fibula transfer (Table III). A total of 6\% of children who were admitted again did not need surgery but underwent ward-based wound management, physiotherapy and rehabilitation, including the measurement and fitting of mobility aids.

In a national survey of surgery in Malawi, Lavy et al\textsuperscript{27} found that 3\% of all operations were for ‘osteomyelitis’, whereas in this study from an elective orthopaedic hospital, 6.7\% of operations on children were for chronic haematogenous osteomyelitis.

Bickler and Sanno-Duanda\textsuperscript{28} demonstrated that osteomyelitis accounted for 15.4\% of 1726 paediatric surgical admissions over 29 months in a government referral hospital in Banjul, in The Gambia. As a measure of bed occupancy, our patients with chronic osteomyelitis made up 7.6\% of all the in-patient days during the same period.

Based on a retrospective review of the hospital records of our patients at a minimum follow-up of one year, we cannot say whether the disease has been eradicated in all 167. However, we believe it is unlikely that these patients would have received orthopaedic care elsewhere, as our hospital is the only unit providing this type of specialist paediatric orthopaedic service in the country.

We would like to thank S. Pharila for database management.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References


