

Melissa Rossaak · Rocco P. Pitto

Osteomyelitis in Polynesian children

Received: 17 August 2004 / Accepted: 28 August 2004 / Published online: 14 October 2004
© Springer-Verlag 2004

Abstract Polynesians, including New Zealand Maori, are known to be prone to bacterial infections. We studied 85 New Zealand children with osteomyelitis requiring admission in a tertiary care hospital in a 2-year period in order to attain information regarding incidence and relative risk. During the observation period, the hospital was responsible for the healthcare of a total population of 103,900 children per annum. An increased relative risk of Polynesian and Maori children to suffer from osteomyelitis was calculated to be 3.84. The major pathogenic organism was *Staphylococcus aureus*. Complications such as extension to adjacent joints or sepsis were a rather rare occurrence. Further research is required to identify whether genetic predisposition or social and environmental circumstances are involved in this phenomenon.

Résumé Les polynésiens, en incluant les Maori de Nouvelle Zélande, sont connus pour être enclin aux infections bactériennes. Nous avons étudié 85 enfants de Nouveaux Zélande avec une ostéomyélite nécessitant l'admission dans un hôpital de soin tertiaire, pendant une période de deux années, pour connaître la fréquence et le risque relatif. Pendant la période d'observation l'hôpital était responsable d'une population totale de 103.900 enfants par année. Un risque relatif augmenté pour les enfants Polynésiens et Maoris de souffrir d'ostéomyélite a été calculé à 3,84. L'organisme pathogène majeur était le staphylocoque doré. Les complications comme l'extension à des articulations voisines ou une septicémie étaient plutôt rares. Des recherches supplémentaires sont nécessaires pour apprécier si une prédisposition génétique ou des circonstances sociales ou environnementales sont impliquées dans ce phénomène.

Introduction

In the past, acute osteomyelitis was considered one of the most devastating diseases in childhood. Prior to the introduction of antibiotics, the mortality from osteomyelitis was reported to be as high as 50%. Nowadays, osteomyelitis no longer remains difficult to treat, although consensus has not been reached on the ideal method of therapy. However, the complications and the possible sequelae still remain a concern. The epidemiology of osteomyelitis has been shown to be changing, with overall incidence declining [3]. It is known that there are marked differences in diseases between Polynesians and Europeans, but the available data on osteomyelitis is minimal. The primary objective of this study was to define the epidemiology and demographic of Polynesian children versus European children with osteomyelitis.

Materials and methods

Children up to the age of 14 years with osteomyelitis treated in a tertiary hospital were reviewed using the Plato computerized audit system in the period between 1 January 2000 and 31 December 2002. The following data were recorded for each patient: age; gender; ethnic group, including Cook Island Maori, New Zealand (NZ) Maori, Pacific Island, Samoan, Tongan, Nieuuan, NZ European, Indian, and other; duration of hospital stay; diagnosis; and laboratory results. Ethnicity was recorded from personal identification cards. Conditions coding for osteomyelitis of the trunk and limbs listed in International Statistical Classification of Diseases and Related Health Problems (10th Revision) (ICD-10) were used for selection. On review of patient notes, any patients who had been coded incorrectly were excluded from the study, as were patients who did not fall in the hospital catchment area.

For inclusion, at least two of the following diagnostic criteria had to be met: (1) localized tenderness, redness, swelling, or reduced mobility, (2) pus aspirated from bone

M. Rossaak (✉) · R. P. Pitto
Department of Orthopaedic Surgery, Middlemore Hospital,
South Auckland Clinical School, University of Auckland,
Auckland, New Zealand
e-mail: mhrossaak@middlemore.co.nz
Tel.: +64-9-2760044
Fax: +64-9-2760288

or draining sinus, (3) growth of bacteria from blood or bone specimen, or (4) radiographic signs of osteomyelitis (radiographs, ultrasound and MRI).

The site of infection was documented as accurately as possible. The method of treatment was noted as non-operative or surgical. The surgical procedure included incision and drainage with washout, as required. Fever, white blood cell (WBC) count, serial erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP) were recorded for all patients. Complications were recorded. Diagnostic specimens for laboratory evaluation included swab samples from wounds and aspirates. Tissue specimens were gram stained if of sufficient quantity. Liquid sterile-site specimens were inoculated into Bac-T/Alert blood culture bottles and processed as blood culture.

For statistical evaluation, Microsoft Excel and SPSS (SPSS, Inc., Chicago, IL, USA) were used in order to calculate baseline data. The relative risk interval has been calculated using the Confidence Interval Analysis (CIA Microcomputer Program Manual, London, England).

Epidemiologic figures were obtained from the Health Profile of Counties Manukau, Auckland, New Zealand [10]. The distribution of ethnic groups of children up to 14 years of age in the hospital catchment area (with a total estimated resident population of 396,000) per annum was as follows: the biggest population was the European group and people of other ethnicity, with 50,900 children per annum. Maoris represented 27,100 children per annum whereas people of the Pacific Islands represented 25,900 children per annum. Middlemore Hospital was, therefore, responsible for the healthcare of 103,900 children per annum in 2000.

Results

The overall number of children (up to 14 years of age) admitted for any reason during the observation period was 59,453 (35,916 Polynesian, including NZ Maori; 23,537 European and Others). We recorded 85 cases of osteomy-

Fig. 1 A 7-year-old New Zealand Maori boy with acute osteomyelitis of the distal right femur requiring surgical drainage. **a** Anteroposterior and lateral view radiographs of the right knee show no bony abnormalities. **b** MRI of the right knee (lateral plane and axial plane, T2-weighted images) show subperiosteal abscess in the posteromedial aspect of the distal femur. The joint appears normal.



elitis. Mean age was 6.7 (median 7) years. There was a male predominance of 55 compared with 30 girls, with a male-to-female ratio of 1.8. Duration of hospital stay ranged between 1 and 80 (mean 15.4 days, median 12) days).

In 52 cases, diagnosis was determined by clinical and radiological findings. Positive radiological findings included plain radiographs ($n=15$), MRI ($n=39$), bone scan ($n=1$), and ultrasound ($n=1$) (Fig. 1). Clinical findings alone were used in 29 patients, and the remaining four patients were diagnosed using intraoperative findings or microbiology results. Thirty-nine patients required operative intervention, which mostly consisted of incision and drainage of a periosteal abscess while 46 were treated with IV antibiotics alone. Fever at admission was noted in 63 patients. The majority of patients ($n=62$) had a normal WBC count (mean value $13,31 \times 10^9$ cells/l). However, the serial ESR was recorded in 79 patients and was raised (greater than 19 mm/h) in 63 patients. CRP was tested in 75 patients, with the values in 73 being raised.

Infection was mostly located in the metaphyseal area of long bones (Table 1). The most common site of infection was the distal femur ($n=17$) followed by the proximal femur ($n=15$). Three children had multifocal sites.

The rated incidence of Polynesian and NZ Maori children sustaining osteomyelitis is 42.8/100,000; the incidence of European or others is 11.1/100,000 (Table 2). The relative risk is rated as 3.84 (95% confidence interval 2.26–6.35) and shows an increased risk of Polynesians or Maori people with osteomyelitis compared to Europeans or children of other origin within the hospital's catchment population. The relative risk of osteomyelitis in Polynesian children versus other ethnicities in the hospital's admissions over the 3-year period was 2.62 (95% confidence interval 1.54–4.46)

Staphylococcus aureus was the most frequent causative pathogen in 38 patients on microbiological culture from

Table 1 Location of osteomyelitis (+1 refers to multifocal site)

Site	Frequency
Distal femur	16+1
Proximal femur	15
Distal tibia	12
Proximal tibia	9
Distal fibula	6
Foot	4
Hand	4
Calcaneus	4
Pelvis	4
Proximal humerus	3
Distal humerus	3
Distal radius	1+1
Distal ulna	+1
Mid fibula	1
Proximal fibula	1
Patella	1
Spine	1
Total	88

Table 2 Ethnic distribution of osteomyelitis in 85 children

New Zealand Maori	25
Polynesian	43
New Zealand European and other origin	17
Total	85

blood, tissue, or swabs, with a further two diagnosed as methicillin-resistant *St. aureus* (MRSA). *Streptococcus pyogenes* was the next most frequent with only four patients providing positive cultures. A single case of each *Neisseria meningitidis* and *Klebsiella kingii* were identified. There was no growth of cultures taken from 26 patients, and seven patients had no specimens sent for microbiology.

Two children had significant recent infections: one had a scalp abscess, which had required incision and drainage, while the other had infected burns. One child was simultaneously diagnosed as having an extradural abscess and required intensive care admission, as did one other for *St. septicemia*. Four children developed septic arthritis of the adjacent joint.

Discussion

The objective of this study was to present epidemiological data showing the ongoing increased risk of children of Polynesian origin, including New Zealand Maori, of acquiring osteomyelitis. Polynesia is described by a triangular area in the Eastern Pacific Ocean that stretches from Hawaii to New Zealand and Easter Island.

Gillespie et al. [7] looked at the incidence of acute hematogenous osteomyelitis between 1965 and 1973 and concluded that the incidence in Maori children was four times that in European children. A further study [6] with data of children with acute hematogenous osteomyelitis between 1965 and 1980 showed that rates in Scotland, England, and Wales are very similar to those in Europe and are significantly lower than those for children of European origin in Australia and New Zealand. Interestingly, Maori and, in particular, Aboriginal children have much higher rates than children of European origin.

The gender and racial differences demonstrated may be genetically or environmentally determined; however, the difference certainly supports at least a multifactorial or polygenic inheritance hypothesis. Ear infections have previously been shown to be more prevalent in Polynesian children [11], as have skin infections [4], both of which are believed to be important factors in the etiology of acute hematogenous osteomyelitis [8, 13].

Controversy and discussion continue as to whether significant ethnic differences in disease frequency are predominantly caused by differences in environmental exposures or by differences in frequency of disease susceptibility genes or, most likely, a combination of both. Abbott et al. [1] identified 59 diseases for which comparisons of their frequency in Polynesians and Europeans had been reported. In 38 of these diseases,

the frequency was consistently higher in Polynesians than in populations of European origin, and in 13 of the diseases, the frequencies were lower in Polynesians. They concluded that it is likely that the majority of diseases that occur at different frequencies in Polynesians and Europeans are multifactorial and due to “constellations” of interacting risk factors, each of which is essential, but not sufficient, for the disease process. Identification of genes that increase susceptibility to these diseases would result in improved strategies for both prevention and treatment.

Hill et al. [9] has shown that people from the Pacific Islands suffer from bacteraemia of *S. aureus* or suffer more often from bone and joint infection [8]. In addition, children of Maori or Polynesian population have a higher incidence of meningitis or pneumonia [1, 14]. This, again, raises the question of how social circumstances are involved. Interestingly though, in one study, the deprivation category score for patients with osteomyelitis versus that for the population in the Greater Glasgow Health Board showed that osteomyelitis was evenly distributed throughout the social spectrum, with no significant difference between the groups [3]. Similar research in New Zealand appears to be showing that low socio-economic status is not a significant risk factor for cellulitis [4]. This has been supported in the past by Tonkin [9] who believed that the high incidence of chest and ear infections in Maori children could not all be attributed to neglect or social conditions, as did Robb [12].

In the present study, the incidence of Polynesian children who acquire osteomyelitis is 42.8/100,000; the incidence of European or other populations is 11.1/100,000. We showed a relative risk of 3.84 underlining the increased risk for Maori and Polynesian children to suffer osteomyelitis in this population. *St. aureus* and *S. pyogenes* were the most frequent pathogenic organism. *S. aureus* is the most frequent microorganism in any type of osteomyelitis [9]. Although males and females have been shown to carry *S. aureus* at a similar rate [2], male dominance in staphylococcal infection has been frequently reported [5]. The validity of the conventional hypothesis of boys injuring themselves more frequently than girls and, thereby, providing a portal of injury has not been established.

The present study has some major drawbacks. First is its retrospective design. Secondly, the observation period was too short to collect all complications, including recurrence

of osteomyelitis. Thirdly, some patients may have been miscoded and, therefore, missed, and lastly, some patients may have been treated in other hospitals.

In conclusion, children of Polynesian origin, including New Zealand Maori, continue to have a significantly increased risk of osteomyelitis. Further research is required to identify whether genetic disposition or social and environmental circumstances are involved in this phenomenon. Identification would lead to more effective preventative measures.

References

1. Abbott W, Scragg R, Marbrook J (1999) Differences in disease frequency between Europeans and Polynesians: directions for future research into genetic risk factors. *N Z Med J* 112:243–245
2. Armstrong-Esther CA (1976) Carriage patterns of *Staphylococcus aureus* in a healthy non-hospital population of adults and children. *Ann Hum Biol* 3:221–227
3. Blyth MJ, Kincaid R, Cragen MA, Bennet GC (2001) The changing epidemiology of acute and subacute haematogenous osteomyelitis in children. *J Bone Joint Surg Br* 83:99–102
4. Finger F, Rossaak M, Umstaetter R, Reulbach U, Pitto RP (2004) Skin infections of the limbs of Polynesian children. *N Z Med J* 117(1192):U847
5. Fisher AM, Trever RW, Curtin JA (1958) *Staphylococcal* pneumonia as observed in twenty-one adults. *Trans Am Clin Climatol Assoc* 69:29–35
6. Gillespie WJ (1979) Racial and environmental factors in acute haematogenous osteomyelitis in New Zealand. *N Z Med J* 90(641):93–95
7. Gillespie WJ (1985) The epidemiology of acute haematogenous osteomyelitis of childhood. *Int J Epidemiol* 14:600–606
8. Hill PC, Wong CGS, Lang SDR (1999) Bone and Joint infection at a tertiary-care hospital: review of one hundred seventy-eight cases. *Infect Dis Clin Pract* 8:368–373
9. Hill PC, Wong CG, Voss LM, Taylor SL, Pottumarthy S, Drinkovic D, Morris AJ (2001) Prospective study of 125 cases of *Staphylococcus aureus* bacteraemia in children in New Zealand. *Pediatr Infect Dis J* 20:868–873
10. Jackson G, Palmer C, Lindsay A, Peace J (2004) Counties Manukau health profile, Counties Manukau District Health Board, Manukau. http://www.cmdhb.govt.nz/Counties/News_Publications/Publicationsframe.htm, accessed April 2004
11. Lines DR (1977) An Auckland high school health survey. *Aust N Z J Med* 7:143–147
12. Robb D (1960) Maori and European: differential incidence of surgical and other diseases. *N Z Med J* 59:271–279
13. Robertson DE (1938) Acute haematogenous osteomyelitis. *J Bone Joint Surg* 20:35–47
14. Tonkin S (1971) Maori infant health. *N Z Med J* 73(466):171