ORIGINAL ARTICLE

An Epidemiologic Investigation of Chronic Osteomyelitis among Pediatric Patients Admitted from 2006 to 2010 at the Philippine General Hospital

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ABSTRACT

Background

Osteomyelitis is a debilitating disease if not properly treated. Epidemiologic and microbiologic data will be of great importance in the direction of treatment.

OBJECTIVE

To determine the epidemiologic and clinical profile of pediatric patients with chronic osteomyelitis admitted at Philippine General Hospital from 2006 to2010.

METHODOLOGY

This is a retrospective study involving a review of medical records of pediatric patients with chronic osteomyelitis admitted at the Philippine General Hospital during the 5 year study period. Frequencies and percentages were computed for nominal data. Comparison of the different variables was done using Chi-square and Fisher Exact test.

RESULTS

Eighty of the 134 cases of pediatric patients with chronic osteomyelitis were reviewed. Twenty-three percent of all operations involved the femur (N=18) and tibia (N=18). On radiograph, the presence of sequestrum was the most common finding noted in 53% of the cases. The predominant organism isolated in bone cultures was MSSA (40%) followed by MRSA (20%). On tissue cultures MRSA was the most common isolate in 34%, followed by MSSA(31%). Majority of the patients were given Oxacillin as empiric therapy (55%).No significant difference was observed with respect to the areas of bone involvement, signs and symptoms, radiologic findings and laboratory parameters between MSSA and MRSA osteomyelitis ($p>0.05$).

CONCLUSION

There were 239 per 100,000 cases of chronic osteomyelitis. The most common bones involved were the femur and tibia with sequestrum as the most common radiologic finding. In the previous studies, MRSA was not reported but was noted in the present study. Most of the patients in our study were treated with both antibiotics and surgery to optimize management. Ninety-eight percent of the cases had significant clinical improvement upon discharge. Based on this study, laboratory parameters, clinical manifestations and area involved cannot be utilized in differentiating MRSA from MSSA osteomyelitis. Further studies are needed to support our findings and isolation of the organism is still required for definitive identification to distinguish between MRSA from MSSA osteomyelitis.

INTRODUCTION

Osteomyelitis refers to the inflammation of bone and marrow and generally implies the presence of infection.[1] In children, the most common mechanism of infection is generally hematogenous in origin, and is most often acute. Chronic osteomyelitis, on the other hand, is often the result of an infection after a surgical procedure, penetrating trauma or from inadequate treatment of acute hematogenous osteomyelitis.

The prevalence of osteomyelitis in children in developed countries is 3 to 14 per 100,000.[2-3] In the United States, each year, 1 in 5000 children under the age of 13 years is diagnosed with osteomyelitis, accounting for 1% of all pediatric hospitalizations.[4-5] In contrast, a hospital in Banjul, Gambia, noted that osteomyelitis accounted for 7.8% of all pediatric surgical admissions and 15.4% of total pediatric inpatient days, second only to burn injury.[6] In the Philippines, based on the Philippine Pediatric Society ICD10 Registry from January 2001 to December 2009, osteomyelitis accounted for only 0.015% (15 per 100,000) of the total pediatric admissions in the country.[7] However, this data only included those patients admitted in general hospitals which can account for the low rate.

The predominant pathogen isolated in cases of osteomyelitis differs depending on the mechanism by which the infection was acquired. Different bacterial pathogens may be involved in acute hematogenous osteomyelitis, but the predominant organism is *Staphylococcus aureus*.[1,3,8-9]. However, a recent study from 33 children's hospitals in the USA found that the prevalence of osteomyelitis caused by Methicillin-resistant *Staphylococcus aureus* (MRSA) increased from 0.3 to 1.4 per 1000 hospital admissions between 2002 and 2007 which suggests that this was driven by the recent emergence of Community Acquired-MRSA strains (CA-MRSA).[10] In post-traumatic chronic osteomyelitis, aside from staphylococci, other organisms isolated are *Enterobacteriaceae*, *Pseudomonas aeruginosa* and *Clostridium* spp.[11]

Osteomyelitis is a debilitating disease if not properly treated. It can seriously affect a child's life physically and emotionally. Up-to-date epidemiologic and microbiologic data will be of great importance to guide the direction of treatment. There being limited studies on osteomyelitis in the Philippines since the late 1990's and due to international evidence regarding the changing epidemiology of osteomyelitis, local data on this disease is needed to guide clinicians in its prevention and treatment.The objective of the study is to determine the epidemiologic and clinical profile of patients, 0 to 18 years old, who were admitted at the Philippine General Hospital for chronic osteomyelitis from 2006 to 2010. Specifically, this study aimed to determine the prevalence of chronic osteomyelitis among the subjects, describe their clinical, microbial, and radiographic profiles and determine the antibiotic susceptibility pattern of common bacterial pathogens.

MATERIALS AND METHODS

Study design

This retrospective study reviewed the medical records of pediatric patients of the Philippine General Hospital from January 2006 to December 2010 who had a final diagnosis of chronic osteomyelitis.

Study Population

All patients aged 0 to 18 years who were admitted during the 5 year period and had a final diagnosis of chronic osteomyelitis were included in the study. Those who had incomplete data were excluded as well as those whose primary reason for admission was surgical follow-up.

Data Collection

The list of patients was collected from the logbooks of the orthopedic ward and the medical records section (ICD 10 codes - K10.2, M46.2, M86.0-M86.9, M90.2). From said record, the following data were obtained: demographic characteristics, clinical

presentation, previous treatment, associated medical problems, physical examination findings, radiologic findings, hematologic work-ups [complete blood count (CBC), erythrocyte sedimentation rate (ESR), C-reactive protein (CRP)], bacteriologic work-up [(blood, bone, tissue and wound tissue gram stain / culture and sensitivity (GS/CS)], antibiotic therapy, surgical procedure/s, length of hospital stay, and clinical outcomes.

Outcomes Measured

For the purpose of this study, osteomyelitis was defined as the inflammation of bone and marrow but generally implies the presence of infection.[1] Chronic osteomyelitis was used to describe an infection when symptoms have been present for more than three weeks at the time of presentation with radiologic findings of sequestration, bone destruction and cloaca formation.[12] Clinical outcomes were categorized into two: (1) Clinical improvement when there was resolution of all signs and symptoms of active infection; and (2) Failure when there was a lack of apparent response to therapy as evidenced by one or more of the following: persistence of drainage, recurrence of sinus tract or failure of sinus tract to close, persistence of systemic or local signs of infection (chills, fever, weight loss, bone pain), or progression of bone infection (as shown by imaging methods).[13]

Statistical Analysis

Prevalence of osteomyelitis in subjects was computed from the total number of diagnosed cases of chronic osteomyelitis over the total number of pediatric admissions.

Data were encoded and tallied in SPSS version 10 for windows. Descriptive statistics were generated for all variables. For nominal data, frequencies and percentages were computed. For numerical data, mean ± SD were generated. Comparison of the different variables under study was done using the following test statistics: (1) Chi-square test was used to compare/associate nominal data; and (2) Fisher Exact test was used to compare/associate nominal data in a 2x2 contingency table.

The study protocol was submitted and approved by the institution's technical and ethics review board.

RESULTS

Of the 134 cases of pediatric patients with chronic osteomyelitis, only 80 charts (60%) were retrieved.

Table 1 shows the demographic profile of patients included in the study. The mean age at presentation was 8 years old and most patients were males (54%), with a male to female ratio of 1.2:1. The mean length of hospital stay was 45 days. Most of the patients (95%) had history of previous medical consultations with other hospitals, private physicians, local health centers or faith healers ("hilot") prior to admission. There was a history of previous antibiotic intake in most patients (79%). Eighty eight percent (88%) of cases had no other co-morbid conditions that can predispose to osteomyelitis. However, two patients were noted to have Arnold Chiari II malformation with sacral decubitus ulcers which later on progressed to osteomyelitis. One patient was diagnosed to have congenital dislocation of the right elbow which later on developed a blister with secondary bacterial infection. Another patient who had a low grade glioma underwent craniectomy and excision of the mass; later on, said patient developed surgical site infection which progressed to osteomyelitis. Notably, 23% of all operations for osteomyelitis involved the femur and tibia. Predisposing factors documented were mostly trauma (35%), wound (13%), abscess (13%) and previous diagnosis of chronic osteomyelitis (9%).

Swelling (27%), draining sinus (24%), non-healing wound (20%) and pain (14%) were the most common presenting signs and symptoms. Swelling, pain/tenderness, draining sinus, purulent discharge, limited motion, erythema and warmth, aside from being common signs and symptoms, were

TABLE 1. Demographic and clinical characteristics of chronic osteomyelitis patients

N= 80	N (%)
Age	2 mos – 18 yrs Mean= 8yrs
Sex	M:F (1.2:1)
Males	43 (54)
Females	37 (46)
Bone involvement	
Single bone involvement	71 (89)
Femur	18 (23)
Tibia	18 (23)
Humerus	10 (13)
Others (Radius, Ulna, Fibula, Metatarsal, Phalanx, Thumb, Clavicle, Ischium, Mandible, Calcaneus, Navicular, Parietal	(<10)
Multiple bone involvement	9 (11)
Radius & ulna	5 (6)
Femur & tibia	2 (3)
Fibula & radius	1 (1)
Tibia & ulna	1 (1)
Predisposing factors	
Trauma	28 (25)
Wound	10 (13)
Abscess	10 (13)
Previously diagnosed with COM	7 (9)
Others (Swelling, Cellulitis, Pain, Fever, Sacral decubitus ulcer, Septic arthritis, Mass, Burn, Congenital deformity, Insect bite, Parotitis, Varicella, Vehicular accident)	(≤5)

TABLE 2. Radiologic findings of chronic osteomyelitis patients

Radiologic findings	N (%)
Sequestrum	4 (53)
Lytic changes	22 (28)
Pathologic fracture	18 (23)
Involucrum	18 (23)
Periosteal reaction	14 (18)
Sclerosis	11 (14)
Soft tissue swelling	9 (11)
Cloacae, Increased joint space, Callus, Lucency, Cortical thickening, Bowing, Deformity, Dislocation, Bone resorption, Hyperdensity, Limb length discrepancy, Osteopenia, No osseous involvement	(<10)
No result	8 (10)

TABLE 3. Microbiologic isolates of chronic osteomylelitis patients

Cultures	**N (%)**
Monomicrobial	66 (56)
Polymicrobial	18 (15)
No growth	25 (21)
No specimen sent	9 (8)
Bone CS	**N = 40**
Staphylococcus aureus	16 (40)
MRSA	8 (20)
Pseudomonas aeruginosa	3 (8)
MRSE, Beta Streptococci Group A, *Enterobacter aerogenes, Serratia marsescens, Staphylococcus epidermidis, Escherichia coli, Proteus mirabilis, Klebsiella pneumonia, Enterobacter cloacae,* Beta-hemolytic Streptococci (Group G)	(<5) 3 (8)
No growth	
Tissue CS	**N = 88**
MRSA	30 (34)
Staphylococcus aureus	27 (31)
Pseudomonas aeruginosa, Staphylococcus epidermidis, Escherichia coli, Enterobacter cloacae, Beta Streptococci Group A, *Enterococcus* sp, *Escherichia coli* (ESBL), Group G Streptococcus, *Morganellamorganii*, MRSE	(<5) 14 (16)
No growth	
Wound swab	**N = 6**
MRSA	1 (17)
Pseudomonas aeruginosa	1 (17)
Streptococcus pyogenes	1 (17)
No growth	3 (50)

also the commonly observed physical examination findings in these patients.

Upon admission and prior to starting treatment, 61% had normal white blood cell count while 29% had elevated results. CRP and ESR were elevated in 30% and 55%, respectively. However, 45% of patients had no CRP and 39% had no ESR determination on admission.

Meanwhile, the microbiologic isolates and radiologic characteristics of the cases were reviewed. The presence of sequestrum (53%) was the most common finding, followed by lytic changes (28%), pathologic fracture (23%), involucrum (23%) and periosteal reaction (18%).

Majority (56%) of the isolates were monomicrobial while 15% had polymicrobial growths. Only 29 (36%) of the 80 patients had bone CS specimens, from which there were 40 isolates. The predominant organism isolated in bone cultures is methicillin-sensitive *Staphylococcus aureus* [MSSA] (40%), followed by methicillin-resistant *Staphylococcus aureus* [MRSA] (20%), and *Pseudomonas aeruginosa* (8%). Sixty-eight (85%) patients had tissue CS

specimens, from which 88 isolates were noted. On tissue cultures, MRSA (34%) was the most common isolate, followed by MSSA(31%). Only six patients had wound swab CS specimens, which were all monomicrobial.

Based on antibiotic susceptibility of the isolates, MSSA was sensitive to clindamycin (98%), erythromycin (93%), oxacillin (98%), chloramphenicol (92%) and cotrimoxazole (96%). On the other hand, MRSA was 100% sensitive to vancomycin, linezolid, cotrimoxazole, gentamicin, with note of 3% resistance to clindamycin and erythromycin. For *Pseudomonas aeruginosa*, there was 100% sensitivity to ceftazidime, ciprofloxacin, meropenem, imipenem and piperacillin-tazobactam.

Most of the patients were treated with both antibiotics and surgery (91%), while 8% were treated with antibiotics alone, and 1% with surgery alone. The patient who was treated with surgery alone was a case of chronic multifocal osteomyelitis and underwent debridement, curettage and sequestrectomy. However, for the group of patients treated with antibiotics alone, it was not indicated in the chart the reasons for not doing surgery.

For empiric therapy, majority (93%) were given Oxacillin (55%) while 26% were given Cefazolin. Eight percent (8%) received a combination of Oxacillin plus an Aminoglycoside (4%). IV antibiotics were given for two weeks in 40% of patients prior to switch therapy (to oral antibiotics) while 15% were given three weeks of IV antibiotics. Total duration of treatment in 33% of patients was 6 weeks while 12% received 4 weeks of therapy.

For the outcome, 78 (98%) patients had significant clinical improvement upon discharge. Two patients who were treated with antibiotics alone were sent home in less than a week and were advised to complete treatment at home with oral antibiotics; their clinical improvement was still not evident at the time of discharge. There was no failure of treatment observed in the review.

Since the most predominant isolates were MSSAand MRSA, laboratory parameters (particularly white blood cell count, C-reactive protein, and erythrocyte sedimentation rate), signs and symptoms and radiologic findings were compared to determine if there was a measurable difference between the two organisms.

Comparison of MSSA and MRSA osteomyelitis in terms of laboratory parameters, signs and symptoms, radiologic findings and area involved showed that there was no significant difference noted as proven by all p values >0.05.

DISCUSSION

Osteomyelitis is an uncommon condition among children but is clinically important since it leads to hospitalization and prolonged antibiotic administration and, most importantly, can cause permanent disability.

In the Philippines, osteomyelitis accounted for only 0.015% (15 per 100,000) of the total pediatric admissions in the country.[7]However, data from the registry only came from general hospitals and not from specialty hospitals. In this study, there were 239 per 100,000 cases of chronic osteomyelitis. The figure is ten times higher than the Philippine data, and this is probably because our institution is a referral hospital which accounts for the discrepancy in rates.

Although most literature in developed countries state that osteomyelitis in children is most often acute, this is not the case in our setting. This is probably due to the fact that our institution is a tertiary referral hospital and most of the patients we saw had been previously managed in another healthcare facility. Another possible reason would be that the acute cases were probably seen and managed in an out-patient clinic. A study in Uganda[14] and Namibia[15]supported our findings with 82% and 55% of cases, respectively, had chronic osteomyelitis. Locally, a previous study done in PGH by Montalban et al, in 1982,[16] showed that of the 89 osteomyelitis cases

reviewed, 94% were chronic. Similarly, a study done in PCMC by Vinluan et al,[17] showed that 72% of the 18 cases reviewed had chronic osteomyelitis.

The mean age at presentation was 8 years old. Thirty-nine percent of cases were ≤6 years old, 38% were adolescents and 24% were school-aged children. Other studies in developed countries showed similar results with a median age at presentation between 4.3 to 10 years old.[2-3,18-19] However, a study in Uganda showed the median age of patients with osteomyelitis to 12.5 years and most of the cases (43%) belonged to the adolescent age group.[14] In the study by Montalban et al[16], involving both adult and pediatric patients, 61% of cases belonged to the 0-15 year age group. Conversely, the study by Vinluan et al[17] showed that 44% were between 2 to 5 years old. This only shows that osteomyelitis can affect all age groups.

In our review, there was a male preponderance, which was compatible with both local[16-17]andinternational studies.[1,14-15,18-20] This may be due to increased incidence of trauma in boys[21]. However, other studies showed an equal distribution of osteomyelitis between sexes.[3,22]

The mean length of hospital stay was 45 days in contrast to another study done in Scotland[2] having a median stay of 9 days. There was no local study to support our findings. In our setting, economics is an important factor because it has a great impact in terms of procurement of medications which could have influenced the prolonged hospital stay of our patients. Another factor is that most of the patients were chronic osteomyelitis cases which also accounted for the longer length of stay.

A single bone was usually affected in most of our cases, however, polyostotic involvement was noted in 11% of patients. Studies done in other countries also observed the involvement mostly of single bones. Polyostotic involvement has been reported in a maximum of 6.8% of cases amonginfants and in 22% among neonates.[23-24] Our findings were consistent with those from other local studies done in the early 90's which showed 12.4% to 12.5% of cases having multiple bone involvements.[16,25] The femur (23%) and tibia (23%) were most commonly involved, which corroborated the findings of other studies.[15,17-18] The metaphysis of the long bones was most often involved because of its rich vascular supply[9]. However, a study in Uganda, showed that the bone most frequently affected were the phalanges and the most common etiology by clinical history was a prick because of traditional beliefs of having been bewitched.[20] In contrast, in most of the studies, it was observed that contiguous osteomyelitis was prevalent usually with an associated wound,[26],history of trauma,[27-28] or occurred after surgery necessary for reconstruction of bone.[28] Similarly, predisposing factors documented in our study were from trauma (35%), wound (13%), abscess (13%) and those previously diagnosed with chronic osteomyelitis (9%). Several factors contributing to the occurrence of infection after trauma were: occurrence of poor perfusion or shock, the viability of tissue following necrosis or hemorrhage, the number and virulence of organisms, host resistance, adequacy of surgical debridement, and underlying co-morbid conditions.[29]

Common chief complaints noted in our study were swelling (27%), draining sinus (24%), non-healing wound (20%) and pain (14%). On the other hand, common signs and symptoms and physical examination findings in these patients were swelling, pain/tenderness, draining sinus, purulent discharge, limitation in motion, erythema and warmth. Other studies involving mostly acute osteomyelitis noted that in addition to swelling, pain, limitation of motion, and redness, fever was also common.[18]In those countries with a high incidence of chronic osteomyelitis, like in our setting, draining sinus was also a common manifestation which is the hallmark of the disease.[30] These findings were also consistent with the clinical manifestations described in the

studies done by Montalban et al[16] and Vinluan et al[17].

Nonspecific blood tests like erythrocyte sedimentation rate and C-reactive protein were widely employed in assessing chronic osteomyelitis. They were usually elevated but have low sensitivities and specificities. Some authors suggested that these blood tests can be helpful in the early diagnosis of post-operative bone infection and in the assessment of effectiveness during the course of antibiotic therapy.[31-32]In our study, CRP and ESR were elevated in 30% and 55% of the cases, respectively. However, 45% of patients had no CRP and 39% had no ESR upon admission. Elevated ESR and CRP were found to be the best laboratory test in some studies for identifying osteomyelitis in patients.[3,33] However, ESR ≥40 mm/hr only had a positive predictive value of 26%,[3] which confirmed that ESR was a non-specific marker for osteomyelitis.[34] In other studies, ESR was elevated in 88% to 92% of osteomyelitis patients, and the rate of a positive test and median or mean ESR value depended on whether these patients had acute, subacute or chronic forms.[19,33] Also, in other local studies, 85% to 86% had elevated results, showing that this parameter was usually elevated.[16,25]

Anemia and leukocytosis were not consistent findings and these were more commonly associated with acute rather than chronic infections.[35] Our findings showed that 61% of patients had a normal white blood cell count while only 29% had elevated results upon admission since our cases were mostly chronic osteomyelitis. The same was true with other local studies, where they found that 73% to 85% of patients had normal WBC values.[16,25]

In this study, plain radiograph showed the presence of sequestrum (53%) as the most common finding, followed by lytic changes (28%), pathologic fracture (23%), involucrum (23%) and periosteal reaction (18%); these were findings seen in chronic osteomyelitis. Although deep, soft tissue swelling can be seen radiographically within the first few days of onset of the disease, osteopenia or osteolytic lesions from destruction of bone were usually not visible until 2 to 3 weeks after onset of symptoms.[36]A maximum of 50% bone destruction is required before a lytic lesion is apparent. The plain radiographs have a sensitivity and specificity of 43% to 75% and 75% to 83%, respectively. In the clinical setting, if bone destruction is detected, no further imaging may be necessary.[21, 36]

In the earlier years, *Staphylococcus aureus* was the main causative agent of chronic osteomyelitis. Other organisms implicated were *Pseudomonas spp, Enterobacteriaceae,* beta-hemolytic *Streptococcus*, *Streptococcus pneumoniae*, and *Escherichia coli.*[21,36-37] In local literatures, *Staphylococcus aureus* was also the most common pathogen noted.[16-17,25] This fact is consistent with our study in which one of the predominant organisms isolated in bone and tissue cultures was *Staphylococcus aureus*. However, MRSA was also seen as a predominant isolate, suggesting that this organism was now emerging in our setting. This was not noted in the previous local studies done. A study done in 33 different children's' hospitals in the USA found that the prevalence of osteomyelitis caused by MRSA increased from 0.3 to 1.4 per 1000 hospital admissions between 2002 and 2007, while the rate of methicillin-sensitive *S. aureus* (MSSA) osteomyelitis remained stable.[10] This evidence confirmed that the microbiology of osteomyelitis is changing.

Treatment of chronic osteomyelitis generally consists of taking appropriate antibiotics and surgical debridement to remove all the dead bone tissue. Microorganisms residing in the dead bone, if not removed along with sequestra (dead bone), can cause flare-ups many years after the initial attack. The goal of debridement is to reach healthy, viable tissues.[13]Most of the patients in our study were treated with both antibiotics and surgery (91%) to optimize management.

Since previous studies have shown that the predominant isolate in chronic osteomyelitis is

Staphylococcus aureus, the empiric antibiotic recommended is an anti-staphylococcal penicillin or a first generation cephalosporin. Our findings showed that most of the patients were given Oxacillin or Cefazolin which can cover this organism. However, with the increasing incidence of MRSA, some studies have recommended the use of vancomycin or clindamycin.

Based on the antibiotic susceptibilities of isolates, *Staphylococcus aureus* was sensitive to clindamycin (98%), erythromycin (93%), oxacillin (98%), chloramphenicol (92%) and cotrimoxazole (96%). On the other hand, MRSA was 100% sensitive to vancomycin, linezolid, cotrimoxazole, and gentamicin with noted 3% resistance to clindamycin and erythromycin which implied that the pathogen may have been community-acquired. Ideally, all erythromycin-resistant and clindamycin-susceptible isolates should be tested for inducible clindamycin resistance by the D-test. Knowing this will help clinicians in the choice of antibiotics once cultures are at hand. In our setting, the occurrence of a positive D-test was reported as clindamycin-resistant.

Duration of antibiotic therapy in chronic osteomyelitis has not been well defined. Four to six weeks of parenteral antibiotic therapy after surgery has become the standard treatment for chronic osteomyelitis. The rationale behind this regimen is that three to four weeks are required for bone to revascularize and is based from the experience obtained in treating children with acute osteomyelitis.[37-39] However, some authors advocate longer treatment with six to eight weeks of intravenous therapy followed by a course of three months or longer of oral therapy because of failure rates observed.In our study, 40% of patients were given two weeks of IV antibiotics prior to switch therapy while 15% were given three weeks of IV antibiotics. Total duration of treatment in 33% of patients was 6 weeks while 12% were given 4 weeks of therapy. Basis for discontinuing treatment was resolution of initial presenting symptoms and decrease of either WBC count, and ESR or CRP by 20%. Standardized treatment recommendations were difficult to make due to the variable courses of the disease so treatment should always be individualized.

Clinical outcome was assessed at the end of the hospital stay. The study showed that 78 (98%) had significant clinical improvement upon discharge. Two patients were treated with antibiotics alone, sent home in less than a week and advised to complete the treatment at home with oral antibiotics, so the clinical improvement was not evident at the time of discharge. A limitation of this study was that follow-up of the patients were not reviewed thereby recurrence, relapse or other complications were not monitored. Despite advances in both antibiotics and surgical treatment, long-term recurrence rate remains at approximately 20% to 30%.[35,40-42] Some factors affecting recurrence rates were whether or not surgical debridement was performed and adequacy of antibiotic therapy.

Since there is now evidence that MRSA is emerging, laboratory parameters, clinical manifestations, radiologic findings and areas involved were compared with those observed with *Staphylococcus aureus* to note if there were measurable differences between the two isolates. Our findings showed that no significant difference was noted in the laboratory parameters between the two organisms. This was similar to a study in New Orleans also showing no significant difference in median WBC count, ESR and CRP values between MSSA and MRSA osteomyelitis. On the contrary, a recent study showed that children with MRSA osteomyelitis had significantly higher erythrocyte sedimentation rate and C-reactive protein values on admission,[42] compared to MSSA osteomyelitis.

In terms of clinical manifestations, it showed that all the signs and symptoms aforementioned were seen in both MRSA and MSSA osteomyelitis. A study comparing the severity of pediatric osteomyelitis attributable to methicillin-resistant versus methicillin-

sensitive *Staphylococcus aureus* showed a significant increase in the degree and duration of fever in those with MRSA osteomyelitis.[43]

There was no significant difference between the two groups in so far as the radiologic findings and areas of bone involvement were concerned. To date, limited studies, which look into differences between MRSA and MSSA osteomyelitis, are available both locally and internationally.

Based on this study, laboratory parameters, clinical manifestations and area involved could not be utilized in differentiating MRSA from MSSA osteomyelitis. Further studies are needed to support our findings and isolation of the organism is still required for definitive identification to distinguish between MRSA and MSSA osteomyelitis.

CONCLUSIONS

Among pediatric patients admitted at the Philippine General Hospital, there were 239 cases of chronic osteomyelitis per 100,000 cases. The mean age at presentation was 8 years old and most patients were males. Most common bones involved were the femur and tibia. The presence of sequestrum was the most common radiologic finding. The predominant organism isolated in bone and tissue cultures was methicillin-sensitive *Staphylococcus aureus* [MSSA] and methicillin-resistant *Staphylococcus aureus* [MRSA]. Laboratory parameters, clinical manifestations and area involved could not be utilized in differentiating MRSA from MSSA osteomyelitis. Further studies are needed to support our findings and isolation of the organism is still required for definitive identification to distinguish between MRSA and MSSA osteomyelitis.

REFERENCES

1. Krogstad P. Osteomyelitis. In: Feigin RD, Cherry JD, Demmler-Harrison GJ, Kaplan SL (eds).Feigin& Cherry's Textbook of Pediatric Infectious Diseases. Philadelphia, PA. Saunders; 2009. p. 725-742.
2. Blyth MJG, Kincaid R, Craigen MAC, Bennet GC. The changing epidemiology of acute and subacute haematogenous osteomyelitis in children. J Bone Joint Surg Br 2001; 83: 99-102.
3. Riise ØR, Kirkhus E, Handeland KS, Flatø B, Reiseter T, Cvancarova M, Nakstad B, Wathne KO. Childhood osteomyelitis-incidence and differentiation from other acute onset musculoskeletal features in a population-based study. BMC Pediatr. 2008 Oct 20;8:45-54.
4. Sonnen GM, Henry NK. Pediatric bone and joint infections. Diagnosis and antimicrobial management. Pediatr Clin North Am. 1996;43(4):933-s947.
5. Vazquez M. Osteomyelitis in children. Curr Opin Pediatr. 2002; 14(1):112-115.
6. Bickler SW, Sanno-Duanda B. Epidemiology of paediatric surgical admissions to a government referral hospital in the Gambia. Bull World Health Organ 2000;78:1330-6.
7. Philippine Pediatric Society ICD10 Registry. [Online] Available http://www.pps.org.ph/index.php?option=com_content&view=article&id=22&Itemid=69
8. Bonhoeffer J, Haeberle B, Schaad UB, Heininger U. Diagnosis of acute haematogenous osteomyelitis and septic arthritis: 20 years experience at the University Children's Hospital Basel. Swiss Med Wkly 2001. 131:575-581.
9. Gutierrez K. Bone and joint infections in children. Pediatr. Clin. N. Am. 2005; 52(3), 779-794.
10. Gerber JS, Coffin SE, Smathers SA, Zaoutis TE. Trends in the incidence of methicillin-resistant *Staphylococcus aureus* infection in childrens hospitals in the United States. Clin. Infect. Dis. 2009; 49(1), 65-71.
11. Patchen ED. Antibiotic prophylaxis in trauma: penetrating abdominal injuries and open fractures. Rev Infect Dis. 1991; 13:S847-57.
12. Montalban AM, Autea FP, Selirio G, Montalban Jr ASC. Osteomyelitis: A surgical emergency. Philip J Emer Care. 1999 Oct; 6(1):21-25.
13. Conterno LO, da Silva Filho CR. Antibiotics for treating chronic osteomyelitis in adults (Review). Cochrane Database Syst Rev. 2009 Jul 8; (3): CD004439
14. Stanley CM, Rutherford GW, Morshed S, Coughlin RR, Beyeza T. Estimating the healthcare burden of osteomyelitis in Uganda. Trans R Soc Trop Med Hyg. 2010 Feb; 104(2):139-42.
15. Lauschke FH, Frey CT. Hematogenous osteomyelitis in infants and children in the northwestern region of Namibia. Management and two-year results. J Bone Joint Surg Am 1994; 76:502-10.
16. Montalban AM, Silvo JV, Nitollma RL. Profile of osteomyelitis at the UP-PGH Medical Center. Acta Medica Phil. April-June 1982; 18(2): 49-56.
17. Vinluan LA, Hontiveros C, Ibarra-Leones A, Resurrecion M, Arellano RG. A profile of osteomyelitis in children at the PCMC: a 5 year review. PCMC Journal. 1992; 1(2): 130.

18. Caksen H, Uzüm K, Yüksel S, Oztürk MK, Türk Y, Ustünbaş HB. Our experience in childhood osteomyelitis. J Nippon Med Sch. 2001 Aug; 68(4):349-50.
19. Auh JS, Binns HJ, Katz BZ. Retrospective assessment of subacute or chronic osteomyelitis in children and young adults. Clin Pediatr (Phila). 2004, 43:549-555.
20. Ibingira CB. Chronic osteomyelitis in a Ugandan rural setting. East Afr Med J 2003; 80:242-6.
21. Steer AC, Carapetis JR. Acute hematogenous osteomyelitis in children: Recognition and management. Paediatr Drugs 2004; 6:333-346.
22. Dahl LB, Hoyland AL, Dramsdahl H, Kaaresen PI. Acute osteomyelitis in children: a population-based retrospective study 1965 to 1994. Scand J Infect Dis 1998, 30:573-577.
23. Offiah AC. Acute osteomyelitis, septic arthritis and discitis: Differences between neonates and older children. Eur J Radiol. 2006.60:221-232.
24. Asmar BI. Osteomyelitis in the neonate. Infect Dis Clin North Am. 1992. 6: 117-132.
25. Caro LD. Chronic Osteomyelitis: Clinical Features and Appraisal of Management. UP-PGH, 1987.
26. Tice AD, Hoaglund PA, Shoultz DA. Outcomes of osteomyelitis among patients treated with outpatient parenteral antimicrobial therapy. Am J Med. 2003 Jun 15; 114(9):723-8.
27. Jones NS, Anderson DJ, Stiles PJ. Osteomyelitis in a general hospital. A five-year study showing an increase in subacute osteomyelitis. J Bone Joint Surg Br. 1987 Nov; 69(5):779-83.
28. Norden C, Nelson JD, Mader JT, Calandra GB. Evaluation of new anti-infective drugs for the treatment of infections of prosthetic hip joints. Infectious Diseases Society of America and the Food and Drug Administration. Clin Infect Dis. 1992 Nov; 15Suppl 1:S177-81.
29. Caplan ES, Hoyt N. Infection surveillance and control in the severely traumatized patient. In: Dixon J, ed. Nosocomial infections. New York: Yorke Medical Books; 1982. p.247-51.
30. Lidgren L, Törholm C. Intramedullary reaming in chronic diaphyseal osteomyelitis: a preliminary report. Clin Orthop Relat Res. 1980 Sep ;(151):215-21.
31. Bourguignat A, Férard G, Jenny JY, Gaudias J, Kempfl. Diagnostic value of C-reactive protein and transthyretin in bone infections of the lower limb. Clin Chim Acta. 1996 Nov 15; 255(1):27-38.
32. Férard G, Gaudias J, Bourguignat A, Ingenbleek Y.C-reactive protein to transthyretin ratio for the early diagnosis and follow-up of postoperative infection. Clin Chem Lab Med. 2002 Dec; 40(12):1334-8.
33. Unkila-Kallio L, Kallio MJ, Eskola J, Peltola H. Serum C-reactive protein, erythrocyte sedimentation rate and white blood cell count in acute hematogenous osteomyelitis of children. Pediatrics. 1994, 93:59-62.
34. Lew DP, Waldvogel FA. Osteomyelitis. Lancet 2004; 364 (9431), 369-379.
35. Waldvogel FA, Medoff G, Swartz MN. Treatment of osteomyelitis. New England Journal of Medicine. 1970; 283(15):822.
36. Pineda C, Vargas A, Rodriguez AV. Imaging of osteomyelitis: Current concepts. Infect Dus Clin North Am 2006; 4:789-825.
37. Carek PJ, Dickerson LM, Sack JL. Diagnosis and management of osteomyelitis. American Family Physician 2001; 63(12):2413-20.
38. Lazzarini L, De Lalla F, Mader JT. Long Bone Osteomyelitis. Curr Infect Dis Rep. 2002 Oct; 4(5):439-445.
39. Lazzarini L, Lipsky BA, Mader JT. Antibiotic treatment of osteomyelitis: what have we learned from 30 years of clinical trials? Int J Infect Dis. 2005 May; 9(3):127-38.
40. Gentry LO, Rodriguez GG. Oral ciprofloxacin compared with parenteral antibiotics in the treatment of osteomyelitis. Antimicrobial Agents & Chemotherapy. 1990; 34(1):40-3.
41. Mader JT, Cantrell JS, Calhoun J. Oral ciprofloxacin compared with standard parenteral antibiotic therapy for chronic osteomyelitis in adults. Journal of Bone Joint Surgery – American Volume. 1990; 72(1):104-10.
42. Saavedra-Lozano J, Mejías A, Ahmad N, Peromingo E, Ardura MI, Guillen S, Syed A, Cavuoti D, Ramilo O. Changing trends in acute osteomyelitis in children: impact of methicillin-resistant Staphylococcus aureus infections. J Pediatr Orthop. 2008 Jul-Aug; 28(5):569-75.
43. Hawkshead JJ 3rd, Patel NB, Steele RW, Heinrich SD. Comparative severity of pediatric osteomyelitis attributable to methicillin-resistant versus methicillin-sensitive Staphylococcus aureus. J Pediatr Orthop. 2009 Jan-Feb; 29(1):85-90.