Microbiology Research Journal International

28(5): 1-14, 2019; Article no.MRJI.48490
ISSN: 2456-7043
(Past name: British Microbiology Research Journal, Past ISSN: 2231-0886, NLM ID: 101608140)

Chronic Osteomyelitis among Children Attending Orthopedic Services at Mbarara Regional Referral Hospital: Prevalence, Etiological Agents and Their Drug Susceptibility Patterns

Tayebwa Edson[1], Kisitu Kyengera[1], Baguma Andrew[2,3] and Bazira Joel[2*]

[1]Department of Surgery, Mbarara University of Science and Technology, Mbarara, Uganda.
[2]Department of Microbiology, Mbarara University of Science and Technology, Mbarara, Uganda.
[3]Department of Microbiology, Central Public Health, Ministry of Health, Uganda.

Authors' contributions

This work was carried out in collaboration among all authors. Author TE conceived the idea of the research, was the principal investigator, and developed the manuscript as well as its review before submission. Author KK supervised the research and contributed to the review of the manuscript. Author BJ supervised the research and contributed to the review of the manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/MRJI/2019/v28i530144
Editor(s):
(1) Dr. Marcin Lukaszewicz, Department of Biotransformation, Faculty of Biotechnology, University of Wroclaw, Wroclaw, Poland and Division of Chemistry and Technology Fuels, Wroclaw University of Technology, Wroclaw, Poland.
(2) Dr. Ana Cláudia Coelho, Department of Veterinary Sciences, University of Trás-os-Montes and Alto Douro, Portugal.
Reviewers:
(1) Maria Demetriou, Metaxa Anticancer Hospital, Greece.
(2) Manas Bajpai, NIMS Dental College, Jaipur, India.
Complete Peer review History: http://www.sdiarticle3.com/review-history/48490

Original Research Article

Received 13 March 2019
Accepted 22 May 2019
Published 03 September 2019

ABSTRACT

Background: This cross-sectional study was conducted to determine prevalence, causative agents and their drug susceptibility patterns of chronic osteomyelitis children among 766 children attending orthopedic services at Mbarara Regional Referral Hospital between October 2016 and June 2017.
Methods: Seventy-four consented patients were consecutively enrolled and their demographic characteristics, clinical and radiological data collected. Superficial and deep bone pus swabs were collected and processed as per standard operative procedures. Susceptibility testing was done using the Kirby Bauer disc diffusion technique. Data was analyzed using Stata version 13.0.

**Corresponding author: E-mail: jbazira@gmail.com;*

Results: The prevalence of children with COM was 9.7%. The female: Male ratio was 1:1.2 with a mean age of 11 years. The most infected bone was the tibia followed by the femur. The common clinical presentations were chronic bone pain and discharging sinus tracts whereas the most imminent radiological features were sequestrum and involcrum. Pus swabs were taken off from both the discharging sinuses and the deep intra osseous abscesses for culture and sensitivity studies. The concordance rate of the microorganisms between the superficial and the deep swabs was 62.5%. *Staphylococcus aureus* was the most predominant microorganism isolated (85%). All the microorganism isolates were sensitive to gentamycin. However, all *Staphylococcus aureus* isolated were resistant to penicillin.

Conclusion: Prevalence of Chronic osteomyelitis among children with orthopedic conditions presenting to MRRH is high. The isolated microorganisms are resistant to antibiotics we commonly use in our settings.

Keywords: Osteomyelitis; chronic; children; culture; pus; sensitivity; resistance; prevalence.

1. BACKGROUND

Osteomyelitis is defined as infection of the bone by pyogenic organisms [1]. Chronic osteomyelitis (COM) is a type of osteomyelitis that is relapsing and persistent characterized by low grade inflammation, presence of sequestrum, involcrum, brodies abscess and fistulous tracts [2].

Chronic osteomyelitis (COM) is a major problem among children presenting with orthopedic conditions in low income countries and this has greatly constrained the resource limited systems of these nations [3]. Its high prevalence in these countries is attributed to immune suppression, malnutrition and high incidence of trauma. It is still a major challenge faced by orthopedic surgeons [4].

Children and adolescents are the age groups commonly affected by COM [5]. In a Ugandan study by Stanley et al., 2010, 80% of the COM patients were below the age of 20 years. In another study carried out in Mityana hospital, peak age incidence was ranging between 10-19 ref years followed by 0-9 years contributing 37.5 and 12.5% respectively and thus it can be concluded that COM is the disease of children [6].

Globally prevalence of childhood osteomyelitis is low, ranging from 3-14/100,000 children [7]. In the United States, each year, 1 in 5000 children under the age of 13 years are diagnosed with osteomyelitis, accounting for 1% of all pediatric hospitalizations [8]. However, in African setting, COM accounted for 7.8% of all pediatric surgical admissions and 15.4% of total pediatric inpatient days ranking second following burns in Gambia [9]. At the Beit cure Hospital - Malawi, COM accounted for 7.6% of total inpatient days and 6.7% of all operations on children [10]. In Kenya surgical operation due COM accounted for 6% of all surgical interventions [11]. In a retrospective multicenter Ugandan Study, there was high prevalence of COM which accounted for over 8.3% of the total outpatients in one year [12]. Whereas 120 patients of COM were seen in Mityana hospital for a period of 5 years from 1996-2000, 38% of the patients presented beyond a period of 6 month of the disease [13].

Long bones are commonly affected in childhood COM, with tibia and femur being the commonest bones affected [14]. The hallmark of COM is bone necrosis which may or may not be accompanied by involcrum formation [15]. Involcrum that forms help in structural support during recovery, but in instance it doesnot form then there is resultant segmental or focal bone loss [16]. Brodies abscess results from a persistent sub-acute infection leading to formation of radiolucent lesion with marginal sclerosis [17]. Another rare type of COM is Garre's sclerosing osteomyelitis and is characterized by massive focal thickening of bone periosteum, chronic non suppurative infection and peripheral reactive bone [18]. This comes as a result of inert stimulation of low grade attenuated infection [19].

The Causative organisms of COM in children depend on the mechanisms by which they were acquired. *Staphylococcus aureus* is the commonest isolated organism in all age groups. The method of isolation of isolation of etiological agent determines whether it's possible to determine the exact organism in question [20]. In chronic osteomyelitis, taking deep bone swabs or bone biopsy is the effective way of identifying organisms and increasing positivity rates of

culture and sensitivity [21]. It is however prudent to note that since the skin surface and bone communicates through sinus tract the organisms cultured from bone biopsy may actually be affected by skin resident flora but not the true causative organisms [22]. Polymicrobial organisms usually isolated when COM is secondary to contiguous spread [23]. Other organisms which have been isolated include *Pseudomonas aeruginosa*, *Escherichia coli*, *Klebsiella pneumoniae*, *Enterobacter cloacae* and *Proteus mirabilis* [24]. Salmonella species have been linked to osteomyelitis in sicklers [25]. Organisms isolated in mandibular and maxillary osteomyelitis are polymicrobial anaerobic and related to oral microbial flora. Common microorganisms often encouterd as causative agents of COM of the jaw include; actinomyces, fusobacterium, parvomonas and staphylococcus [26].

Over the past decade there has been an emerging drug resistance to many microorganisms, for example methicillin resistant *Staphylococcus aureus* (MRSA) and extended spectrum beta lactamases in gram negative bacteria. This has in turn altered the antibiotic regimen used to treat COM [27]. Vancomycin is being used for treatment of MRSA and ampicillin resistant Enterococcus but there is reported emerging vancomycin-resistant *Staphylococcus aureus* and vancomycin-resistant Enterococci which has left us with no choice of antibiotics to use [11].

Chronic osteomyelitis has a far reaching impact on the patient, the health workers as well as the health facility. This is because COM is difficult to treat and most patients treated get recurrence of the disease. Central to treatment of COM is surgical debridement and antibiotic therapy. Treatment failure is thought to be caused by delay in presentation, misdiagnosis and drug resistance among other contributing factors. In rural settings like Mbarara Regional Referral Hospital (MRRH), laboratory services to perform culture and sensitivity (C&S) are limited which contribute to poor antibiotic stewardship like empirical antibiotic usage in COM.

A review of records for a period of one year (1st September 2014 to 1st September 2015) in MRRH, Orthopedics outpatient's clinic, out of 1291 children who attended the clinic, 200 children (15.5%) had COM but the numbers were dominated by re attendances. Out of 200 children with COM, 43 patients were attending the clinic for the second time and nineteen patients had visited the clinic more than twice both constituting 31% of re attendances.

Chronic osteomyelitis is the disease of underdeveloped world. There are scanty prospective studies conducted in sub-Saharan Africa comparable to our setting which will guide us on the common causative organism of chronic osteomyelitis and choice of antibiotic which are effective in treatment of chronic osteomyelitis patients. This study will bridge this gap and help us to identify common causative agents and their susceptibility patterns.

Despite all this, the current prevalence of COM in MRRH is not documented and the commonest causative agents and their susceptibility patterns in MRRH are not known. This makes it a neglected condition over masked by trauma and maternal-child related conditions when it comes to logistics allocation. The current study sought to determine prevalence, causative agents and drug susceptibility patterns of COM in children attending orthopedic services in Mbarara Regional Referral Hospital.

2. METHODOLOGY

This was a cross sectional study, conducted between October 2016 to June 2017 at orthopedic department in MRRH located in South western Uganda. The study involved children between xxx years of age and presented with orthopedic condition. A sample size of 74 was used as calculated according to Kish-Leslie formula (1965).

Study procedures. Following admission of 74 children with COM, parents/ guardians for those children consented for them to participate in the study. They were subjected to a standard preset questionnaire. Data collected included; social demographics, co-morbid factors for COM, history of previous treatment, bones infected with COM, presenting complaints, physical findings and radiological features on x-ray radiographs.

Laboratory procedures Pus swabs were either collected from superficial sinus tract or from bone/bone marrow intra-operatively following bone debridement procedures carried out by principal investigator under orthopedic surgeon's guidance. Strict aseptic technique was followed.

In addition to pus swabs, blood sample were corrected for HIV and Hepatitis B testing. Pus swabs together with blood samples were

delivered to the laboratory by the research assistant immediately after collection in a suitable transport media and were received by the laboratory technician.

Glass slide smears were made from the pus swabs received in the laboratory and gram stain carried out. Gram stained smears were then read under microscope for morphological characteristics of causative agents.

In addition the pus swabs were cultured on chocolate plate agar, blood agar and MacConkey agar and incubated at 35-37°C for 24-48 hours. Incubated plates were read thereafter for culture characteristics shown by organisms on respective culture media. Gram stain and biochemical tests were also performed on culture growth to further identify the causative agents.

Pure cultures from primary culture plates were emulsified into a sterile normal saline in a test-tube, vortexed for two minutes and inserted into densitometer to determine 0.5 McFarland standard turbidity. Sterile swabs were soaked in the suspension, excess drained off the walls of the test-tube. The swab was then used to smear evenly on the surface of muller hinton agar to obtain an evenly distributed growth of organisms. Selected antibiotic discs were placed at different positions on the surface of the medium and incubated at 35-37°C for 24-48 hours.

Controls strains for *Staphylococcus aureus* and *E. coli* were prepared in the same way and similar antibiotics applied. Zones of inhibition of corresponding antibiotics were determined and interpreted as per CLSI guidelines for different organisms.

Antibiotics tested include; ceftazidime, ciprofloxacin, gentamycin, co tromoxazole, chloramphenicol, imipenem, tetracycline, erythromycin, penicillin G, oxacillin and ampicillin.

Data generated was entered into epi-info version 7.2 and exported to stata version 13 for cleaning and analysis. Demographic data, associated factors, etiology and susceptibility patterns of microorganisms causing chronic osteomyelitis was presented by frequency distribution, percentages mean and standard deviation whereas prevalence of children with COM in proportion and percentages.

3. RESULTS

A total of 74 patients out of 766 children who attended orthopedic services at Mbarara Regional Referral Hospital had chronic osteomyelitis. The prevalence of chronic osteomyelitis was 9.7.

A total of seventy four (74) patients were enrolled. Majority were males and Mean age of the participants was 11 years with standard deviation 4.7 years. Children aged 10 years above were the predominantly affected age group.

Eleven patients (14.9%) had multifocal chronic osteomyelitis (more than one bone affected). Of the eleven patients, three patients had both femur and tibia affected, five patients had both humerus and femur, two patients both femur and phalange and one humerus and tibia. Three patients were HIV positive.

The most common presenting complaint was chronic bone pain discharging sinus and swelling the least being protruding bone fragment.

Limited motion presented as the most common complication of COM in children presenting to MRRH.

As shown in Table 3, the tibia and femur were the most affected while the metacarpals were the least affected bones.

On examination majority of patients presented with tenderness while the least of patients had exposed bony fragment.

Most frequent radiological features found were sequestrum and involcrum and the least radiological feature was pathological fracture.

Overall, cultured pus swabs that had similar isolated organisms from both sample showed 62.5% concordance but Proteus and *Staphylococcus aureus* showed 100% and 46.7% respectively.

All the gram negative organisms isolated were bacilli, no any cocci was isolated. They all showed total resistance to ampicillin and tetracycline but no any resistance against gentamycin.

The only isolated gram positive cocci were *Staphylococcus Aureus* and they were all resistant to penicillin G, but no any resistance to gentamycin.

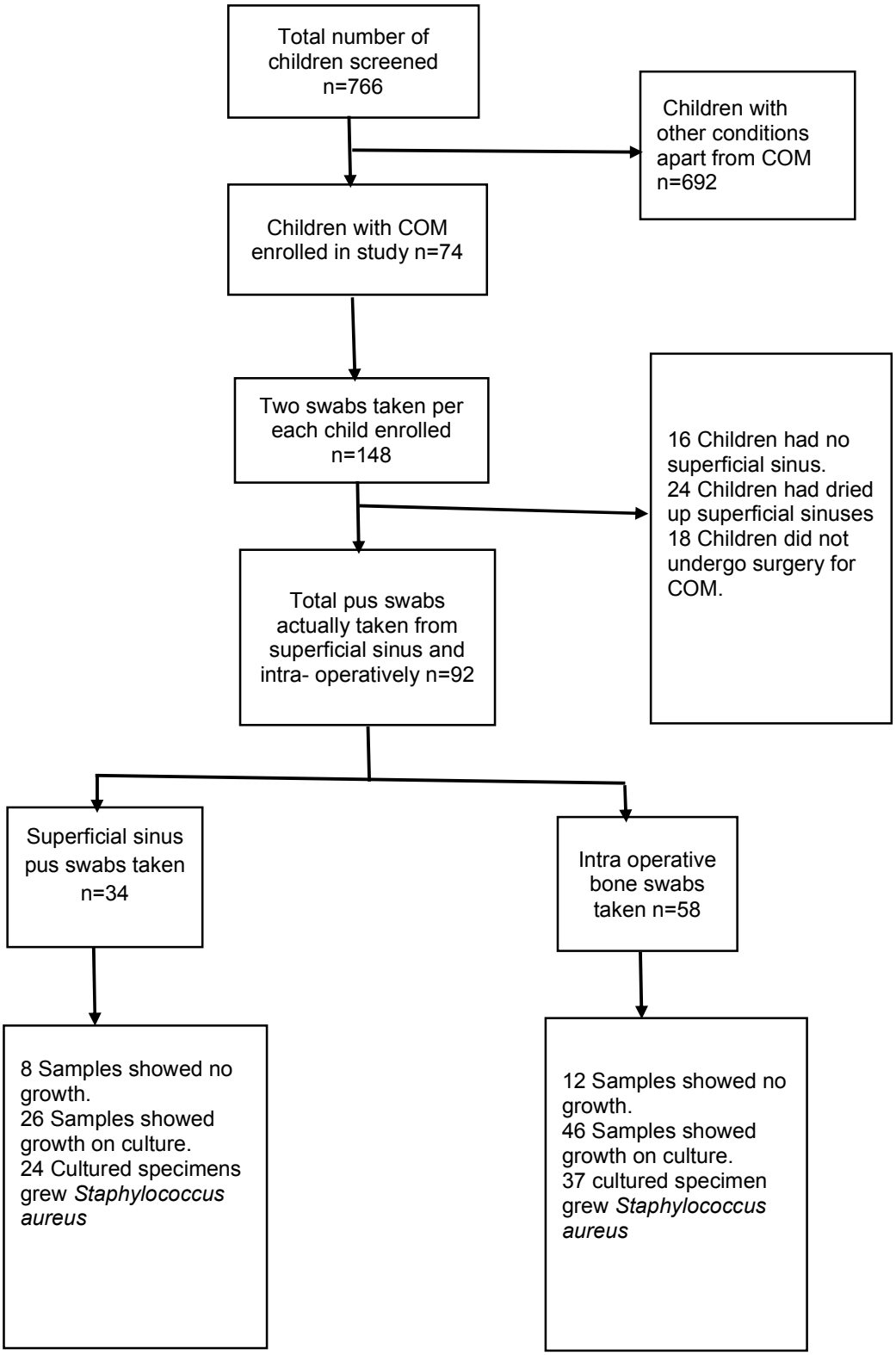

Fig. 1. Study profile

Table 1. Demographic characteristics of children with COM

Characteristics	
Age in years, mean (SD)	10.9 (4.7)
Age categories, n (%)	
<5 years	9 (12.1)
5-9 years	17 (23)
10-17 years	48 (64.9)
Sex, n (%)	
Male	41(55.4)
Female	33(44.6)
District, n (%)	
Mbarara	25 (33.8)
Bushenyi	13(17.6)
Isingiro	9(12.1)
Others	27 (36.5)

Table 2. Medical characteristics of the children with COM. N=74

Characteristics	
Referral status, n (%)	
Referral in	31 (41.9)
Self-referral	43 (58.1)
History of previous surgical treatment of COM before, n (%)	
No.	65 (87.8)
Yes.	9 (12.2)
Duration of symptoms in weeks, median [IQR]	52 [24-156]
Duration of symptoms categories, n (%)	
<6 months	17 (23)
6 months -1yr	16 (21.6)
1-2yrs	21 (28.4)
>2yrs	20(27.0)
History of antibiotic use, n (%)	
No antibiotic use	40(54.1)
Antibiotics used.	34(45.9)
Number of bones infected, n (%)	
single	63(85.1)
multiple	11(14.9)
HIV/AIDS test, n (%)	
Negative	71(96.0)
Positive	3 (4.0)
HepBsAg test, n (%)	
Negative	70 (94.6)
Positive	4 (5.4)

Table 3. Clinical and radiological characteristics of the children with chronic osteomyelitis, N=74

Presenting complaints	n (%)
Chronic bone pain	69 (93.2)
Discharging sinus	63 (85.1)
Swelling	60 (81.1)
Fever	32 (43.2)
Protruding bone fragment	10 (13.5)

Complications of COM.	**n (%)**
Limited range motion	61 (82.4)
Muscle wasting	27 (36.5)
Soft tissue abscess	20 (27.0)
Malnutrition	9 (12.2)
Anaemia.	6 (8.1)
Affected bones	**n (%)**
Tibia	28 (37.8)
Femur	24 (32.4)
Humerus	13 (17.6)
Fibula	7 (9.5)
Ulna	4 (9.5)
Radius	3 (4.1)
Pharanx	3 (4.1)
Metatarsal	2 (2.7)
Radiological features	**n (%)**
Sequestrum	63 (85.1)
Involcrum	59(79.7)
Brodies abscess	18 (24.3)
Periosteal reaction	10 (13.5)
Pathological fracture	5 (6.8)
Examination features	**n (%)**
Tenderness	68 (91.9)
Scar / wounds	62 (83.8)
Bodily deformity	58 (78.4)
Irritability	14 (18.9)
Exposed bone	9 (12.2)

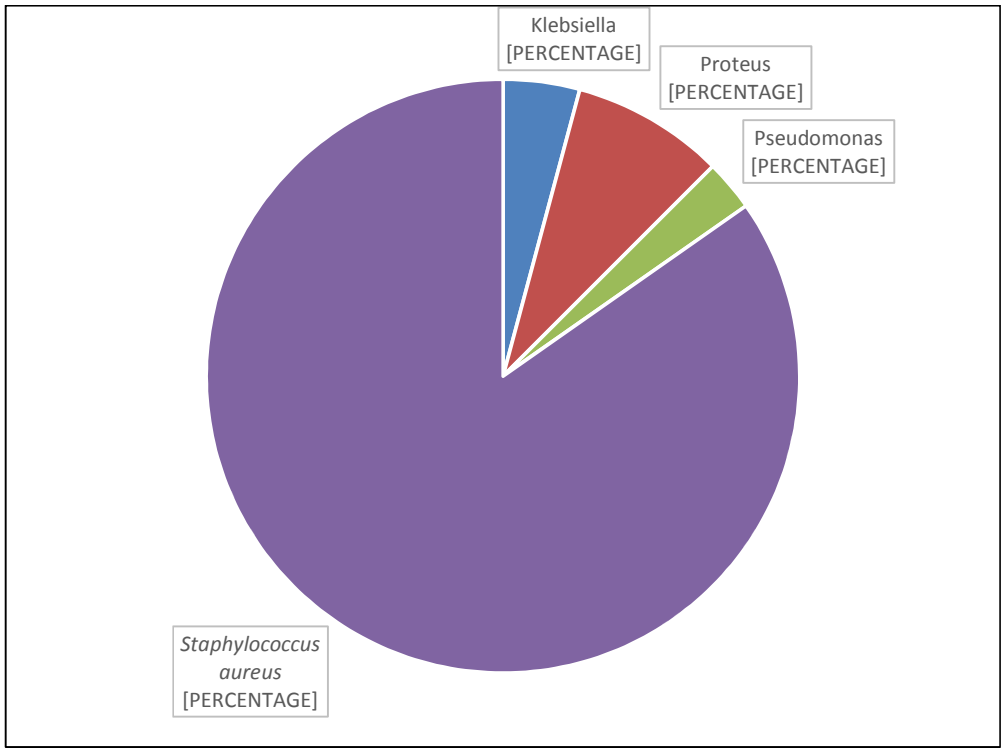

Fig. 2. Pie chart showing causative agents isolated on culture from pus swabs

Table 4. Microbiologic concordance of superficial sinus swab with deep bone swab in children with COM, N=24

Microorganisms isolated	Superficial sinus isolates	Deep bone swab isolates	Superficial sinus isolate agreeing with deep bone sample isolate	Concordance in percentages
Staphylococcus aureus	12	11	7	46.7
Proteus	3	3	3	100
Klebsiella	1	0	0	0
No growth	7	5	5	50
Mixed growth	3	0	0	0

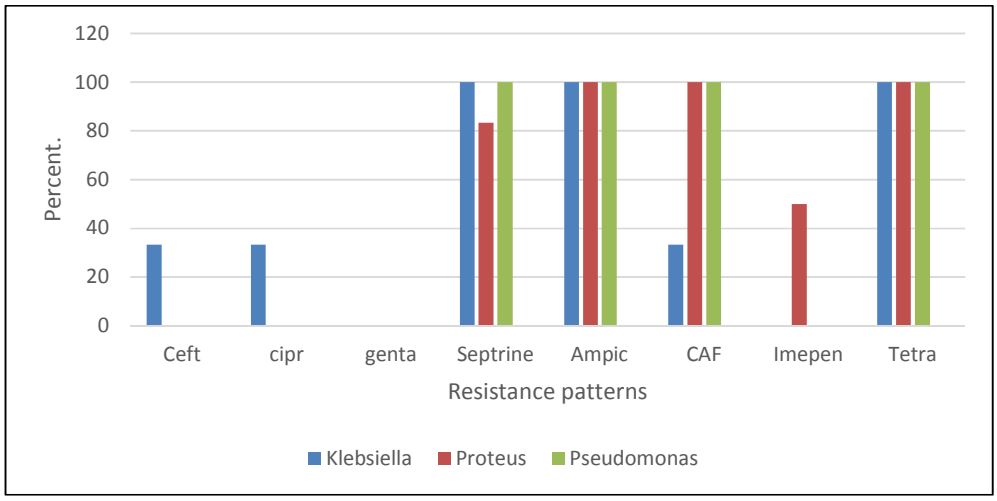

Fig. 3. Graph showing overall percentage drug resistance patterns for gram negative bacilli isolated

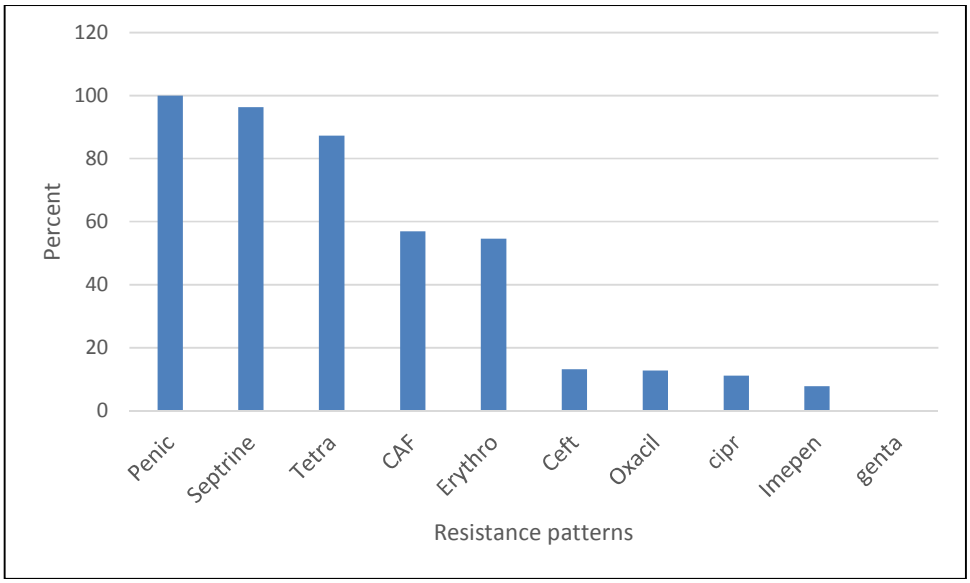

Fig. 4. Graph showing overall percentage drug resistance patterns for gram positive cocci *(Staphylococcus aureus*) isolates

4. DISCUSSION

The prevalence of 9.7% for COM was observed in this study. This agrees with other studies conducted in Uganda [12], Gambia [9], Malawi [28] and Togo [29] which reported prevalence as 10%, 7.8%, 6.7% and 7.4% respectively.

In contrast a study conducted in Norway where prevalence of COM in children was 13/100,000 [30]. The explanation here could be the fact that in developed world there is better health care system that in our setting and children with early signs of bone infection are treated early before it progresses to become COM and better health systems.

There were more males compared to females children with COM with F:M ratio of 1:1.2 The result is similar to that of studies conducted elsewhere which gave the F: M ratios as 1:1.4 in Nigeria [31], 1:1.1 in Uganda [6] and 1:2.7 in Tanzanian [32] studies respectively. This could probably be because the above studies were conducted in geographical location similar to ours and that males participate in activities that predispose them to trauma compared to females.

These findings however are different from what was reported in Kenya [11] and USA [33] where males were slightly less than female in male: female ratio of 1:1.3 for both studies.

Mean age of the children with COM was 10.9 years and majority of the children were 10- 17 years of age. This is similar to that found in a prospective comparative study conducted in Nigeria [31] and Kenya [11] in which the mean age was 11 and 11.9 years respectively. This is an indication that COM is predominant in school going age. School going children are more prone to COM probably due to the fact that they are active and prone to trauma.

Nine patients (12%) still had COM despite previous surgical treatment of COM. This is similar to what was reported in a study conducted in Kenya that found a 12.2% relapse following a 12 month follow up [11]. The reason for persistence of symptoms following surgical treatment could be due to lack of follow up for such patients and failure to appropriately control local surgical site sepsis. Such infection may spread locally and affect already vulnerable bone tissue.

The findings are different from what was reported in a study conducted in Malawi which reported that 16% of the COM patients required a second admission for surgery so as to control infection [28]. This is a higher percentage compared to our study and this may be due to the fact that Beit cure hospital in which the Malawi study was conducted is a specialized orthopedic center and receives referral cases of complicated COM cases from peripheral hospitals all over the country. More so COM is complex to treat despite combined surgery and antibiotic use [34]. In our setting recurrence of COM may be attributed to poor adherence to long term antibiotic treatment and lack of follow up that leads to neglected infected sites.

Additionally poor health seeking behavior where by patients present with advanced and complicated disease involving more than one bone or even one bone but with multiple areas of infection. This study found 15% of patients to have more than one bone to be affected.

The median time from disease onset to presentation was 13 month (range 6 -38 month) This duration is higher than what was found in a Tanzanian study where median duration of symptoms was 7 month [32]. This could be because patients tend to first seek other alternative traditional medicine before entering into formal health care system. Whereas others prefer self-medication because of financial constraints which delays them from presenting to hospital in time.

The median time from disease onset to presentation was less than what was found in the study conducted in Germany on children admitted from Africa where mean duration of illness was 18 month (range 11-60 month) [35]. This may have resulted from delay that occur from the time of identification of patient, transfer and arrival to German from where they were treated.

Three patients (4%) were HIV positive. This is similar to study conducted in Malawi which reported HIV/AIDS did not influence the prevalence of chronic in children [36]. The reason could be due to the fact that all children are started on antiretroviral therapy the moment they are diagnosed with HIV infection and they don't develop immunosuppression hence not at risk to develop COM compared to their counterpart.

This was different from what was reported in South African study where HIV test was positive

in 30% of children with COM [4]. More than a half of such children had CD4 count less than 336c/ul and not on antiretroviral therapy. This could be due the high prevalence of HIV infection in South Africa and also due to immunosuppression in those said children.

The majority of the patients with COM presented with chronic bone pain and discharging sinus. This is similar to what was reported in the systemic review which found pain and tenderness as classical diagnostic features [37] and in Germany where all patients recruited had discharging sinuses [35]. This is probably due to the fact that most of the patients don't go to the hospital until they develop persistent and unrelenting pain and unsightly pus oozing out of the sinus.

Tibia and femur were most affected bones accounting for 37.8% and 32.4% respectively. This is in agreement with the studies` done in Malawi [28], Nigeria [31] and Tanzania [32] in which the results indicated the tibia and femur as most frequently affected bones in frequencies 48.4% & 29%, 40 & 34%, 40 & 24% respectively. This could be because in children tibia and femur which the bones of the lower limbs are usually exposed because these children put on shorts (for the males) and dresses (females) so their legs as well as thighs are predisposed to trauma in active school going children which is the major risk COM. Additionally since the tibia and femur are in close proximity to each other, it is easy for the infection to spread from one bone to the other either hematogenously or locally.

To the contrary, the study by Ibingira found that phalanges were the most affected bone [6]. This could be attributed to the fact that study included both children and adults. The adults were more involved in farming and pastoralism and may have had their fingers pricked by thorns and stick while in the farms and bushes.

Physical examination finding revealed that over 90% of children with COM had bony tenderness and scars/wounds/superficial sinuses. This is in agreement with what the patients came in reporting as their presenting complaints. The above finding is similar to studies in Nigeria [38] and Switzerland [39] that reported bony tenderness and fistulus sinus tract as the predominant physical findings in children with COM. This maybe the reason why patients after trying alternative care chose to seek orthopedic care.

On radiological findings, majority of the patients had sequestrum and involcrum accounting for 85.1 and 79.7 percent respectively. This is similar to a Germany study which noted that sequestrum and invocrum was the commonest feature of COM in children (Gerhard Walter et al. 2012). The reason could be that progression to COM is marked by formation of necrotic bone which later stimulates new bone formation to engulf and support the dead bone.

Twenty four (24.3%) of the children with COM had Brodie's abscess on plain radiography this is different from a Nigerian study that reported 2.4% of the children with osteomyelitis who had Brodie's abscess [40]. This gross difference could be attributed to the social economic status in our setting where many children walk bare footed and end up getting foot infection that is later propagated to develop Brodie's abscess.

Out of 94 cultured specimens collected from both sinus tracts and intra operative bone swab, 22% showed no growth. This finding is similar to what was reported in other studies conducted in Malawi [28] and India [41] which showed that 29% and 16% respectively of the samples had negative growth. The reason behind this may be due to the fact that majority of patient presented when they had received antibiotics from peripheral health units. Also fastidious organisms like mycobacteria tuberculosis that don't grow on ordinary media may have brought about high rate of negative cultures since these were not taken care of. Additionally, in immunocompetent patients, pus is always composed of dead white blood cells and debris of dead microorganisms thus in such cases culture will turn out to be negative.

The microorganism predominantly isolated on culture was *Staphylococcus aureus* representing 85 percent of specimen cultured that showed growth. This is similar to what was found in studies conducted in Kenya [11], Malawi [28], Brazil [42] and Germany [35] which reported that *Staphylococcus aureus* was the commonest cause of COM. This could be because *Staphylococcus aureus* is the abundant normal flora on skin and mucus membranes and therefore easily access to the blood stream in case of trauma or breach in skin which commonly occur in trauma. Once in blood stream in combination with other factors like trauma can cause COM.

However, elsewhere in Oxford UK despite the fact that *Staphylococcus aureus* was a predominant microorganism a lower percentages (32%) was reported [43]. This is a very low proportion compared to what was found in this study. This could be due to the fact that UK study was in a developed country which is a different geographical location when compared to our study.

The concordance for *Staphylococcus aureus* isolates between superficial sinus swabs and deep bone swab was 46.7% and that of all microorganisms was 62.5%. The results found in this study are not different from what was found in Nigeria [31] and Columbia [16] where overall concordance was 41.4% and 30% respectively. The reason could be that on superficial sinus tracts other organisms different from the causative agent can colonize the open sinus tracts since it is exposed to the external environment but the deep bone pus swab does not contain colonizing skin or superficial sinus flora.

Staphylococcus aureus showed marked resistance to co trimoxazole (100%), penicillin (100%) and tetracycline (87.3%). This is similar to what was found in a retrospective study conducted in Moshi Tanzania where resistance against erythromycin, co timoxazole and tetracycline was noted [32]. These are commonest available oral drugs over the counter cheap and accessible and they are not regulated in the community, therefore abused.

More than 80% of *Staphylococcus aureus* isolates were sensitive to gentamycin, ceftazidime, ciprofloxacin and imipenem. Gentamycin and ceftazidime are intravenous treatments which can only be accessed in the hospital setting hence not abused in communities and ciprofloxacin surprisingly is one of the drug that is cheap and easily accessible in our setting but still showed marked sensitivity. These findings are similar to those in Lubega et al study who also noted that gentamycin and ceftriaxone were 100% sensitive whereas ciprofloxacin was significantly sensitive [44]. These findings however differs from what was found in the study conducted in India where *Staphylococcus aureus* was resistant to gentamycin, erythromycin, ciprofloxacin and co trimoxazole in more than 50% of the isolates [27]. This wide spread resistance could be due to higher proportion of MRSA and extended spectrum beta lactamase producers in developed nations. Further still ceftazidime together with other cephalosporin are commonly used empirically and could the reason behind the rise in resistance.

Imipenem was sensitive to more than 80% of isolated *staphylococcus aureus* a similar finding in study conducted in India [41]. This could be due to the fact that imipenem is a new antibiotic on the drug market and has not developed resistance.

Gram negative bacilli were resistant to co trimoxazole, ampicillin and tetracycline and chloramphenicol and in more than 50 percent of isolates the finding that is similar to what was found in an Indian prospective study where all isolates were resistant to co trimoxazole ampicillin and tetracycline when used as a single antimicrobial agent [44]. These are drugs that have been in use in our setting for a long time, easy to access and cheap and hence abused by patients. They have developed resistance and no longer effective against gram negative bacilli.

Gentamycin, ciprofloxacin and ceftazidime were sensitive to gram negative bacilli in more than 50% of the patients this is different to what was found in Indian study where more than 50 % gram negative bacilli isolates were resistant to the above antibiotics [41]. It is important to note that this study was conducted in a high income country which is experiencing extended spectrum resistance gram negative strains and that could be the reason for the discrepancy.

Fifty percent (50%) of Proteus isolates were resistant to imipenem but no resistance in other gram negative bacilli which was quite surprising as it's a new drug in use in our setting and only reserved for patients with persistent infections. this is quite different from what was found elsewhere in India where imipenem showed no resistance [41]. This could be due to the how often patients is exposed to the antibiotics as this is a drug often used in our setting for severe gram negative sepsis. The number of gram negative isolates was small and this could affect the whole picture on imipenem resistance.

5. CONCLUSION

Chronic osteomyelitis accounted for 9.7% of all children attending orthopedic services at MRRH. Of the children who attended, common presentation was discharging sinus and bone pain. Tibia and femur were most commonly affected bones and *Staphylococcus Aureus* was

the predominant isolated microorganism. Isolated organisms were resistant to penicillins, cotrimoxazole and tetracycline but sensitive to gentamycin, imipenem and ceftriaxone.

CONSENT AND ETHICAL APPROVAL

This study was approved by the Faculty of Medicine Research Committee (FRC), MUST Institutional Research Ethics Committee (IREC) and MRRH administration. Study procedures were explained to patients before asking them to participate. Informed written consent was sought from parent/guardian and assent also was obtained in all children with at least 8 years before enrollment into the study. All the information obtained was kept confidential.

ACKNOWLEDGEMENTS

The authors thank the members of department of surgery, the research assistant, technicians of microbiology laboratory MUST, and their sponsors, African Development Bank (ADB). The authors also acknowledge all contributors to the study at all stages of proposal development, data collection and data analysis.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Yeo A, Ramachandran M. Acute haemato-genous osteomyelitis in children. BMJ. 2014;348:66.
2. Cleland J, Ali MM, Shah I. Trends in protective behaviour among single vs. married young women in sub-Saharan Africa: The big picture. Reproductive Health Matters. 2006;14:17-22.
3. Baldan M, Gosselin RA, Osman Z, Barrand KG. Chronic osteomyelitis management in austere environments: The International Committee of the Red Cross experience. Tropical Medicine & International Health. 2014;19:832-837.
4. Marais L, Ferreira N, Aldous C, Le Roux T. The pathophysiology of chronic osteomyelitis. SA Orthopaedic Journal. 2013;12:14-18.
5. Peltola H, Pääkkönen M. Acute osteo-myelitis in children. New England Journal of Medicine. 2014;370:352-360.
6. Ibingira C. Chronic osteomyelitis in a Ugandan rural setting. East African Medical Journal. 2003;80:242-246.
7. Ponio SS, Delos Reyes CA. An epidemiologic investigation of chronic osteomyelitis among pediatric patients admitted from 2006 to 2010 at the Philippine General Hospital. Pediatric Infectious Disease Society of the Philippines Journal. 2013;14:14-23.
8. Pugmire BS, Shailam R, Gee MS. Role of MRI in the diagnosis and treatment of osteomyelitis in pediatric patients. World Journal of Radiology. 2014;6:530.
9. Bickler SW, Sanno-Duanda B. Epidemio-logy of paediatric surgical admissions to a government referral hospital in the Gambia. Bulletin of the World Health Organization. 2000;78:1330-1336.
10. Stevenson AJ, Jones HW, Chokotho LC, Beckles VL, Harrison WJ. The beit CURE classification of childhood chronic haematogenous osteomyelitis—A guide to treatment. Journal of Orthopaedic Surgery and Research. 2015;10:144.
11. Mantero E, Carbone M, Calevo M, Boero S. Diagnosis and treatment of pediatric chronic osteomyelitis in developing countries: Prospective study of 96 patients treated in Kenya. Musculoskeletal Surgery. 2011;95:13-18.
12. Stanley CM, Rutherford GW, Morshed S, Coughlin RR, Beyeza T. Estimating the healthcare burden of osteomyelitis in Uganda. Transactions of the Royal Society of Tropical Medicine and Hygiene. 2010; 104:139-142.
13. Ibingira C. Chronic osteomyelitis in a Ugandan rural setting. East African Medical Journal. 2004;80:242-246.
14. Kumar A, Singh U. Keywords chronic osteomyelitis, gram stain, culture and sensitivity, antibiotic. Bacteriological Pattern of Chronic Osteomyelitis-A Retrospective Study; 2017.
15. Arube-Wani J, Jitta J, Ssengooba LM. Adolescent-friendly health services in Uganda. Promoting adolescent sexual and reproductive health in east and southern Africa. 2008;214.
16. Zuluaga AF, Galvis W, Saldarriaga JG, Agudelo M, Salazar BE, Vesga O. Etiologic diagnosis of chronic osteomyelitis: A prospective study. Archives of Internal Medicine. 2006;166:95-100.
17. Agrawal P, Sobti A. A brodie's abscess of femoral neck mimicking osteoid osteoma:

Diagnostic approach and management strategy. Ethiopian Journal of Health Sciences. 2016;26:81-84.
18. Zarrate JAS, Serna SR, Rodas MRB, Ortiz CHB, Parrado CMP, Cardona JR. Osteomielitis crónica recurrente multifocal. Reporte de tres casos y revisión de la literatura. [Multifocal recurrent chronic osteomyelitis: Report of three cases and review of the literature.]. Revista de la Asociación Argentina de Ortopedia y Traumatología. 2018;83:283-290.
19. Gumber P, Sharma A, Sharma K, Gupta S, Bhardwaj B, Jakhar KK. Garre's sclerosing osteomyelitis-A case report. Journal of Advanced Medical and Dental Sciences Research. 2016;4:78.
20. Lima ALL, Oliveira PR, Carvalho VC, Cimerman S, Savio E. Recommendations for the treatment of osteomyelitis. Brazilian Journal of Infectious Diseases. 2014a;18: 526-534.
21. Hatzenbuehler J, Pulling TJ. Diagnosis and management of osteomyelitis. American Family Physician. 2011;84:1027.
22. Fernandez DC, Utoyo GA, Suganli AK. Bacterial resistance pattern to cephalosporin in patient with chronic osteomyelitis at Dr. Hasan Sadikin General Hospital Bandung. Althea Medical Journal. 2016;3: 376-381.
23. Baum F. Researching public health: Behind the qualitative-quantitative methodological debate. Social Science & Medicine. 1995;40:459-468.
24. Plummer ML, Ross DA, Wight D, Changalucha J, Mshana G, Wamoyi J, Todd J, Anemona A, Mosha FF, Obasi AI. A bit more truthful: The validity of adolescent sexual behaviour data collected in rural northern Tanzania using five methods. Sexually Transmitted Infections. 2004;80:ii49-ii56.
25. Organization WH. Unicef & Activities, U. N. F. F. P. Trends in maternal mortality: 1990 to 2010: WHO, UNICEF, UNFPA, and The World Bank estimates, World Health Organization; 2012.
26. Gaetti-Jardim Júnior E, Fardin AC, Gaetti-Jardim EC, Castro ALD, Schweitzer CM, Avila-Campos MJ. Microbiota associated with chronic osteomyelitis of the jaws. Brazilian Journal of Microbiology. 2010;41: 1056-1064.
27. Wadekar MD, Naganath M, Venkatesha D. Detection of ESBL, MBL and MRSA among isolates of chronic osteomyelitis and their antibiogram. Int J Curr Microbiol App Sci. 2015;4:289-95.
28. Beckles V, Jones HW, Harrison W. Chronic haematogenous osteomyelitis in children. Bone & Joint Journal. 2010;92: 1138-1143.
29. Abalo A, Patassi A, James YE, Walla A, Sangare A, Dossim A. Risk factors for surgical wound infection in HIV-positive patients undergoing surgery for orthopaedic trauma. Journal of Orthopaedic Surgery. 2010;18:224-227.
30. 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 Pediatrics. 2008;8:45.
31. Akinyoola A, Adegbehingbe O, Aboderin A. Therapeutic decision in chronic osteomyelitis: Sinus track culture versus intraoperative bone culture. Archives of Orthopaedic and Trauma Surgery. 2009; 129:449-453.
32. Ali AM, Maya E, Lakhoo K. Challenges in managing paediatric osteomyelitis in the developing world: Analysis of cases presenting to a tertiary referral centre in Tanzania. African Journal of Paediatric Surgery. 2014;11:308.
33. Lazzarini L, Lipsky BA, Mader JT. Antibiotic treatment of osteomyelitis: What have we learned from 30 years of clinical trials? International Journal of Infectious Diseases. 2005;9:127-138.
34. Marais L, Ferreira N, Aldous C, Le Roux T. The management of chronic osteomyelitis: Part II-Principles of post-infective reconstruction and antibiotic therapy. SA Orthopaedic Journal. 2014;13:32-39.
35. Wirbel R, Hermans K. Surgical treatment of chronic osteomyelitis in children admitted from developing countries. African Journal of Paediatric Surgery. 2014;11:297.
36. Jones HW, Beckles V, Akinola B, Stevenson A, Harrison W. Chronic haematogenous osteomyelitis in children. J Bone Joint Surg Br. 2011;93:1005-1010.
37. Grimbly C, Odenbach J, Vandermeer B, Forgie S, Curtis S. Parenteral and oral antibiotic duration for treatment of pediatric osteomyelitis: A systematic review protocol. Systematic Reviews. 2013;2:92.

38. Ikpeme I, Ngim N, Ikpeme A. Diagnosis and treatment of pyogenic bone infections. African Health Sciences. 2010;10:82.
39. Van Schuppen J, Van Doorn MM, Van Rijn RR. Childhood osteomyelitis: Imaging characteristics. Insights into imaging. 2012; 3:519-533.
40. Olasinde A, Oluwadiya K, Adegbehingbe O. Treatment of Brodie's abscess: Excellent results from curettage, bone grafting and antibiotics. Singapore Medical Journal. 2011;52:436-439.
41. Khatoon R, Khan SA, Jahan N. Antibiotic resistance pattern among aerobic bacterial isolates from osteomyelitis cases attending a Tertiary care hospital of North India with special reference to ESBL, AmpC, MBL and MRSA production. International Journal of Research in Medical Sciences. 2017;5:482-490.
42. Jorge LS, Chueire AG, Rossit ARB. Osteomyelitis: A current challenge. The Brazilian Journal of Infectious Diseases. 2010;14:310-315.
43. Sheehy S, Atkins B, Bejon P, Byren I, Wyllie D, Athanasou N, Berendt A, Mcnally M. The microbiology of chronic osteo-myelitis: Prevalence of resistance to common empirical anti-microbial regimens. Journal of Infection. 2010;60:338-343.
44. Lubega A, Joel B, Justina Lucy N. Incidence and etiology of surgical site infections among emergency postoperative patients in mbarara regional referral hospital, South Western Uganda. Surgery research and practice; 2017.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle3.com/review-history/48490