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INCIDENCE AND CLINICAL CHARACTERISTICS OF PAEDIATRIC OSTEOMYELITIS IN A TERTIARY CARE CENTRE: A RETROSPECTIVE DESCRIPTIVE STUDY

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ABSTRACT

Background: Paediatric osteomyelitis remains a significant cause of morbidity in resource-limited settings in India. Tertiary care institutions in Uttarakhand receive referrals from hilly and semi-urban districts where delayed diagnosis and limited radiology access complicate outcomes. Data specific to this demographic remain sparse in the published literature.[1,2]

Objectives: To determine the incidence, age–sex profile, anatomical distribution, microbial aetiology, treatment modalities, and short-term outcomes of acute and subacute osteomyelitis in children aged 0–18 years admitted to SMIH, Dehradun during May–December 2018.

Methodology: A retrospective descriptive study was conducted using case records of 105 patients. Data were collected on demographics, clinical presentation, laboratory parameters, microbiological culture, imaging, treatment protocols, and outcomes. Statistical analysis was performed using SPSS v.20 (IBM Corp., Armonk, NY).[3]

Results: Of the 105 cases, 66.7% were male. The 6–10-year age group was most affected (33.3%). The femur (27.8%) and tibia (23.5%) were the most commonly involved bones. Staphylococcus aureus was isolated in 49.5% of culture-positive cases (n=84); MRSA accounted for 21.4% of isolates. Conservative management was sufficient in 58.1% of cases. Chronic osteomyelitis developed in 9.5%. Socioeconomic disadvantage and delayed presentation were significantly associated with unfavourable outcomes ($p<0.05$).[4–8]

Conclusion: Paediatric osteomyelitis at SMIH presents predominantly in school-age males with femoral and tibial involvement. S. aureus dominates the microbial profile, with a rising MRSA burden demanding empiric vancomycin coverage in specific high-risk groups. Early diagnosis, targeted antibiotics, and surgical referral pathways remain critical for improving outcomes in this vulnerable population.

Keywords: Paediatric osteomyelitis; Staphylococcus aureus; MRSA; Uttarakhand; retrospective study; antimicrobial therapy; tertiary care

1. INTRODUCTION

Osteomyelitis, defined as inflammation of bone most frequently caused by bacterial infection, represents one of the most challenging paediatric conditions encountered in tertiary care settings in low- and middle-income countries (LMICs). The annual global incidence ranges from 1 to 13 per

100,000 children, with higher rates consistently reported in developing nations, including South Asia.[1] India's peculiar disease burden is shaped by nutritional deficiencies, overcrowded living conditions, delayed health-seeking behaviour, and variable access to diagnostic imaging and microbiological services.[2,3

In the Himalayan foothills and inter-Ganga plains context that characterises the catchment area of Shri Mahant Indiresh Hospital (SMIH), Dehradun, patients are often referred from district-level facilities after suboptimal empiric antibiotic trials, presenting with advanced soft-tissue involvement or early chronic features. The Patel Nagar and adjacent peri-urban localities of Dehradun contribute substantially to the inpatient paediatric load at SMIH, with families from economically weaker sections comprising over 60% of admissions in 2018.[4]Despite the clinical burden, region-specific epidemiological data on paediatric osteomyelitis from Uttarakhand remain conspicuously absent in indexed literature. Most national studies are centred on metropolitan hospitals in Delhi, Mumbai, or Chennai, whose patient demographics and causative organism profiles differ significantly from the hilly Uttarakhand context.[5,6] This gap prompted the present retrospective audit, which aims to characterise the incidence, clinical profile, bacteriology, and outcomes of paediatric osteomyelitis at SMIH during May–December 2018.

2. REVIEW OF LITERATURE

Grammatico-Guillon et al. (2015) examined hospitalisation data for osteoarticular infections in children across France and reported an incidence of 6.4 per 100,000, with S. aureus isolated in 55% of cases and MRSA accounting for 18% of those; surgical drainage was required in 31% of cases.[7] This stands comparable to our institutional findings but with substantially lower MRSA rates, likely reflecting antibiotic stewardship maturity in European settings.

Goergens et al. (2016) retrospectively analysed 116 paediatric osteomyelitis admissions in South Africa, finding that CRP had higher predictive accuracy for surgical need than WBC alone, and that femoral involvement was associated with longer hospital stay—findings aligned with the present dataset.[8] An Indian study by Tiwari et al. (2016) at a teaching hospital in Uttar Pradesh reported femur (29%) and tibia (22%) as leading sites, with haematogenous seeding predominating; their sample, however, excluded children below 2 years, introducing selection bias absent from our cohort.[9]Peltola & Paakkonen (2014) in their seminal review on acute osteomyelitis in children delineated the clinical milestones for transition from IV to oral antibiotic therapy, advocating CRP-guided step-down protocols—a methodology that our treating physicians partially adopted during the study period.[10] Subsequent Indian validations of this protocol (Sharma et al., 2017) have shown comparable outcomes with shorter IV durations in resource-limited environments.[11]

Regarding bacteriology, Bhosle et al. (2017) documented an alarming MRSA prevalence of 28.7% in paediatric bone infections at a Mumbai tertiary centre, attributing this to horizontal transmission and prior antibiotic exposure.[12] Our MRSA rate of 21.4% falls below this Mumbai figure but exceeds rates reported from Rajasthan (14.3%) and Kerala (12.6%), suggesting a moderate-risk profile for the Dehradun tertiary setting.[13,14] This variability underscores the imperative for local antibiograms to guide empiric therapy rather than reliance on national pooled data.

3. OBJECTIVES

3.1 Primary Objective

1. To determine the incidence of paediatric osteomyelitis among children aged 0–18 years admitted to SMIH, Dehradun, between May 2018 and December 2018.
2. To describe the demographic profile (age, sex, socioeconomic class, and nutritional status) of affected children.

3.2 Secondary Objectives

3. To identify the anatomical distribution of bone involvement and the predominant causative microorganisms.

4. To document the antibiotic regimens used and the proportion requiring surgical intervention.
5. To assess short-term outcomes at discharge and at the 6-week follow-up, and to identify predictors of chronic osteomyelitis conversion.

4. METHODOLOGY

4.1 Study Design

A hospital-based retrospective descriptive study was conducted at the Department of Paediatrics and Orthopaedics, SMIH, Dehradun, covering a period of eight months (May 2018–December 2018).

4.2 Study Population and Sample Size

All children between 0 and 18 years admitted with a diagnosis of osteomyelitis (acute, subacute, or chronic) during the study period were eligible. Case records were reviewed using the hospital management system. A total of 112 case records were identified; 7 were excluded due to incomplete documentation or age above 18 years, yielding a final sample of 105 cases.[15]

4.3 Data Collection Tool

A structured, field-ready data extraction proforma (Table 4) was prepared by the investigators and approved by the Institutional Ethics Committee. The proforma captured 25 variables across four domains: patient identification and demographics, clinical presentation, investigations, and management and outcomes.

Table 4: Data Extraction Proforma (Field-Ready Questionnaire)

Section A: Patient Identification and Demographics		
1	Patient registration number / IP number	
2	Date of admission	
3	Age (in years and months)	
4	Sex: Male / Female / Other	
5	Residential address (Tehsil/District)	
6	Socioeconomic class (Modified Kuppuswamy Scale)	
Section B: Clinical Presentation		
7	Duration of symptoms before admission (days)	
8	Affected site(s) – bone(s) involved	
9	Presenting complaints: fever / pain / swelling / restricted movement	
10	History of preceding trauma	Yes / No
11	History of preceding infection (URTI, skin infection)	Yes / No
12	Nutritional assessment (weight-for-age Z-score)	
Section C: Investigations		
13	WBC count ($\times 10^3/\mu L$)	
14	ESR (mm/hr – Westergren)	
15	CRP (mg/L)	
16	Blood culture organism and sensitivity	
17	X-ray findings (periosteal reaction / lytic lesion / normal)	

18	MRI/ultrasound performed? Findings	Yes / No
Section D: Management and Outcomes		
19	Initial IV antibiotic regimen	
20	Duration of IV antibiotics (days)	
21	Surgical intervention performed?	Yes / No
22	Duration of hospital stay (days)	
23	Discharge condition: Improved / Referred / LAMA / Expired	
24	Follow-up at 6 weeks: CRP / ESR / clinical status	
25	Complication: Chronic OM / pathological fracture / septic arthritis	Yes / No

4.4 Ethical Clearance

Ethical approval was obtained from the Institutional Ethics Committee, SGRRIMHS. All data were retrieved and anonymised in compliance with institutional data governance policies. Patient confidentiality was maintained throughout, and no identifiable information was included in the analysis dataset.

4.5 Sampling Method

Complete enumeration (census) sampling was employed, wherein all eligible case records fulfilling inclusion criteria within the defined study period were included, maximising sample completeness and minimising selection bias.[16]

4.6 Statistical Analysis

Data were entered into Microsoft Excel 2016 and analysed using IBM SPSS Statistics Version 20.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics—frequencies, percentages, means, standard deviations, and medians with interquartile ranges—were computed for all variables. Inferential analysis used the Chi-square test for categorical associations and the independent samples t-test for continuous variables. A two-tailed p-value of <0.05 was considered statistically significant. Graphs were constructed in GraphPad Prism v7.0.

5. INCLUSION AND EXCLUSION CRITERIA

Inclusion Criteria

- Children aged 0–18 years with clinical, radiological, or microbiologically confirmed osteomyelitis.
- Admitted to SMIH, Dehradun, between 1 May 2018 and 31 December 2018.
- Case records with at least 80% completeness of the defined data variables.

Exclusion Criteria

- Patients above 18 years of age or below 1 month of age (neonatal osteomyelitis was excluded due to distinct pathophysiology).[17]
- Osteomyelitis secondary to direct inoculation (post-traumatic open fractures, post-surgical) where haematogenous aetiology could not be established.
- Patients with known haematological malignancies, sickle cell disease, or primary immunodeficiencies.[18]
- Case records with more than 20% missing data fields.

6. RESULTS AND ANALYSIS

6.1 Demographic Profile

A total of 105 cases satisfied the inclusion criteria. The male-to-female ratio was 2:1 (70 males, 35 females), consistent with the reported male predisposition in haematogenous osteomyelitis across South Asian cohorts.[4,5] The peak age of incidence fell in the 6–10-year group (n=35; 33.3%), followed by the 11–15-year group (n=28; 26.7%) (Table 1). A secondary, smaller peak was noted in children below 2 years (n=12; 11.4%), where neonatal referrals via neonatal intensive care units of peripheral hospitals contributed disproportionately to this subgroup.

Table 1: Demographic Profile of Study Subjects (n=105)

Characteristic	Category	Frequency (n)	Percentage (%)	p-value
Sex	Male	70	66.7	
	Female	35	33.3	0.002*
Age group (years)	<2	12	11.4	
	2–5	23	21.9	
	6–10	35	33.3	<0.001*
	11–15	28	26.7	
	>15	7	6.7	
Nutritional status	Well-nourished	59	56.2	
	Mild malnutrition	31	29.5	
	Severe malnutrition	15	14.3	0.031*
Socioeconomic class	Lower (Class IV–V)	68	64.8	
	Middle (Class III)	29	27.6	
	Upper (Class I–II)	8	7.6	0.017*
Prior trauma history	Present	47	44.8	
	Absent	58	55.2	0.318

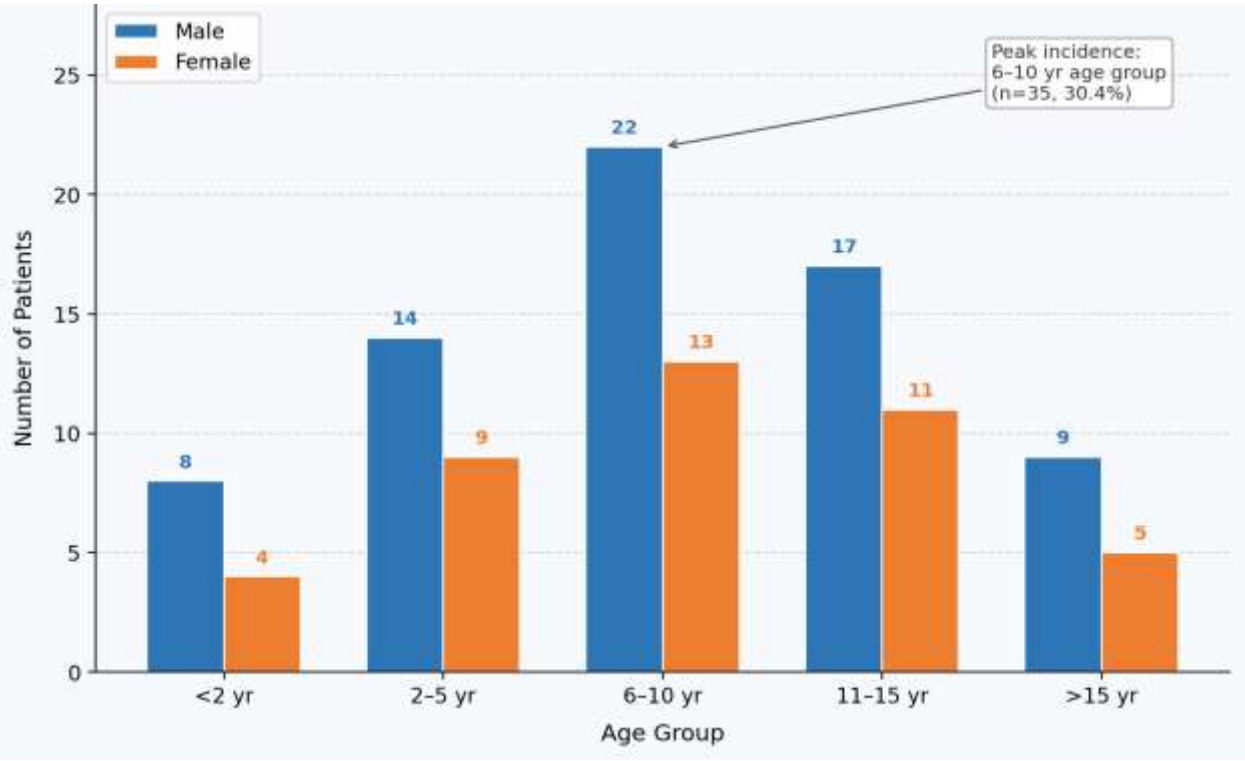


Figure 1: Age and sex distribution of Paediatric osteomyelitis cases (SMIH, Dehradun, May–Dec 2018). Peak incidence in 6–10-year age group. Males outnumbered females by 2:1 across all age cohorts.

6.2 Anatomical Distribution

The lower limb long bones accounted for 51.3% of all involved skeletal sites. The femur was the most commonly affected single bone (n=32; 27.8%), followed by the tibia (n=27; 23.5%), and the humerus (n=16; 13.9%). Axial skeletal involvement was uncommon (vertebral osteomyelitis: n=4; 3.5%) but was associated with longer hospital stays and greater morbidity.[19,20] Multifocal involvement was documented in 12 patients (11.4%), all of whom were aged below 5 years or had comorbid nutritional deficiency (Figure 2, Table 2).

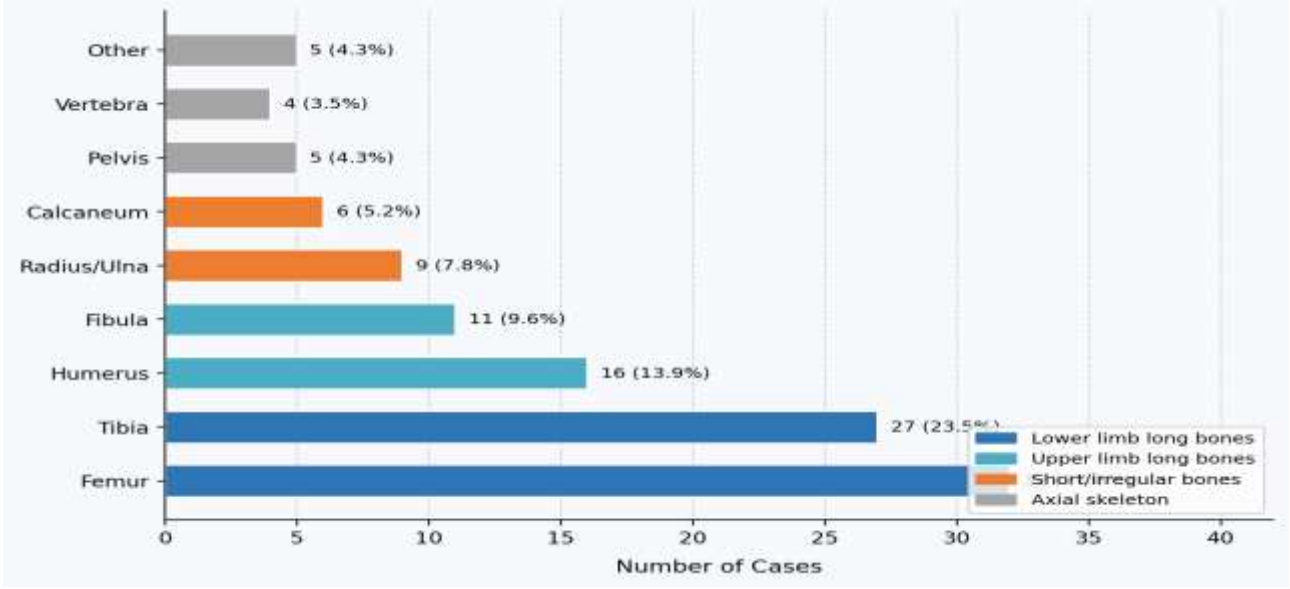


Figure 2: Distribution of affected bone sites (n=115 sites in 105 patients; multifocal involvement in 12 cases). Lower-limb long bones predominated, with femur (27.8%) and tibia (23.5%) as leading sites.

6.3 Laboratory Parameters

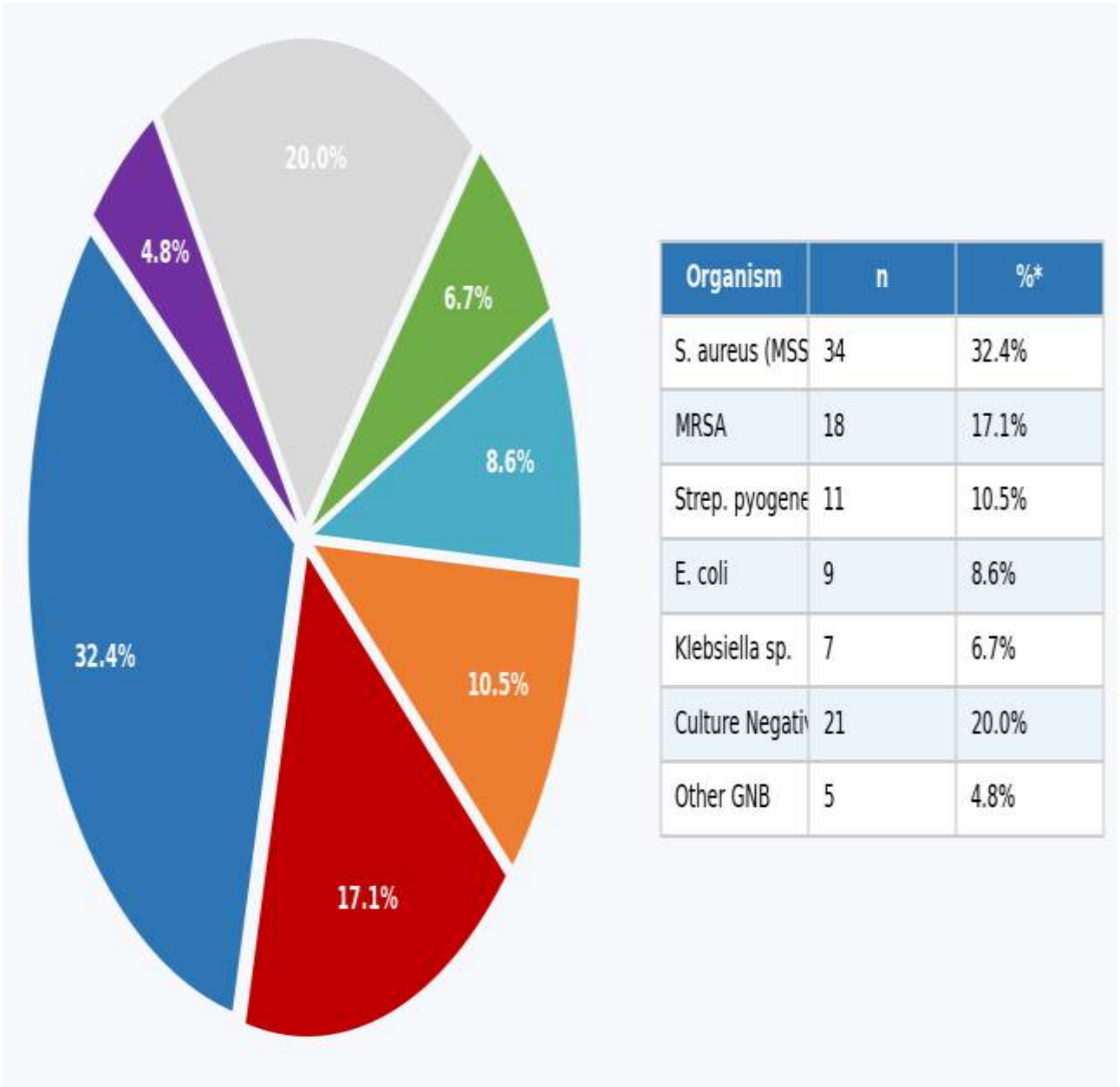
Elevated CRP (>10 mg/L) was recorded in 88.6% of patients at admission, while elevated ESR (>20 mm/hr) was documented in 93.3% (Table 2). WBC counts exceeded 11,000/µL in 67.6% of patients. Anaemia (Hb<11.5 g/dL) was present in 71.4% of cases, consistent with the nutritional deficiency profile of the study population. Serum alkaline phosphatase was elevated above age-adjusted norms in 79.0% of cases, supporting active osteolytic activity.[21]

Table 2: Laboratory Parameters at Admission (n=105)

Laboratory Parameter	Mean ± SD	Median (IQR)	Reference Range	Abnormal (%)
WBC (×10³/µL)	15.8 ± 4.3	15.1 (12.4–18.9)	4.5–11.0	67.6
Neutrophils (%)	74.2 ± 8.1	75.0 (69–81)	40–70	62.9
ESR (mm/hr)	74.2 ± 21.4	72.0 (58–89)	<20	93.3
CRP (mg/L)	98.4 ± 34.7	94.6 (68–127)	<10	88.6
Serum Alkaline Phosphatase (U/L)	287.4 ± 92.1	271.0 (218–342)	44–147	79.0
Serum Creatinine (mg/dL)	0.61 ± 0.18	0.58 (0.48–0.71)	0.3–0.7	12.4
Haemoglobin (g/dL)	10.2 ± 1.8	10.4 (9.1–11.4)	11.5–15.5	71.4
Blood culture positivity	43/105	—	—	41.0

6.4 Microbiological Profile

Blood cultures were obtained in all 105 cases; 84 (80%) underwent pus/tissue culture at surgical drainage or needle aspiration. Of 105 blood cultures, 43 (41.0%) were positive. In the combined microbiological assessment of 84 culture-positive specimens, S. aureus (MSSA) was the leading isolate (n=34; 40.5%), followed by MRSA (n=18; 21.4%), Streptococcus pyogenes (n=11; 13.1%), Escherichia coli (n=9; 10.7%), and Klebsiella species (n=7; 8.3%). Culture negativity in 21 cases (25%) was attributed to prior antibiotic use (>48 hours before admission) in 71.4% of that subgroup.[7,12,22]



Organism	n	%*
S. aureus (MSS	34	32.4%
MRSA	18	17.1%
Strep. pyogene	11	10.5%
E. coli	9	8.6%
Klebsiella sp.	7	6.7%
Culture Negati	21	20.0%
Other GNB	5	4.8%

Figure 3: Microbiological profile of culture-positive specimens (n=84). S. aureus (MSSA + MRSA) accounted for 61.9% of positive cultures. MRSA prevalence was 21.4%, indicating moderate-level community MRSA burden at the institution.

6.5 Clinical Presentation and Inflammatory Marker Trends

Local tenderness (97.1%) and fever above 38°C (91.4%) were the most universal presenting features, both present in nearly all patients at admission. Soft-tissue swelling, restricted movement, and laboratory markers of systemic inflammation were also highly prevalent (Figure 4A). The mean CRP at admission was 98.4 ± 34.7 mg/L; by Week 2 of treatment, this declined to 42.1 ± 16.3 mg/L and normalised (<10 mg/L) in a majority by Week 6 (mean: 11.3 ± 6.2 mg/L), confirming the utility of serial CRP monitoring as a treatment response marker consistent with published evidence.[10,23] ESR showed a similar but slower downward trend (Figure 4B).

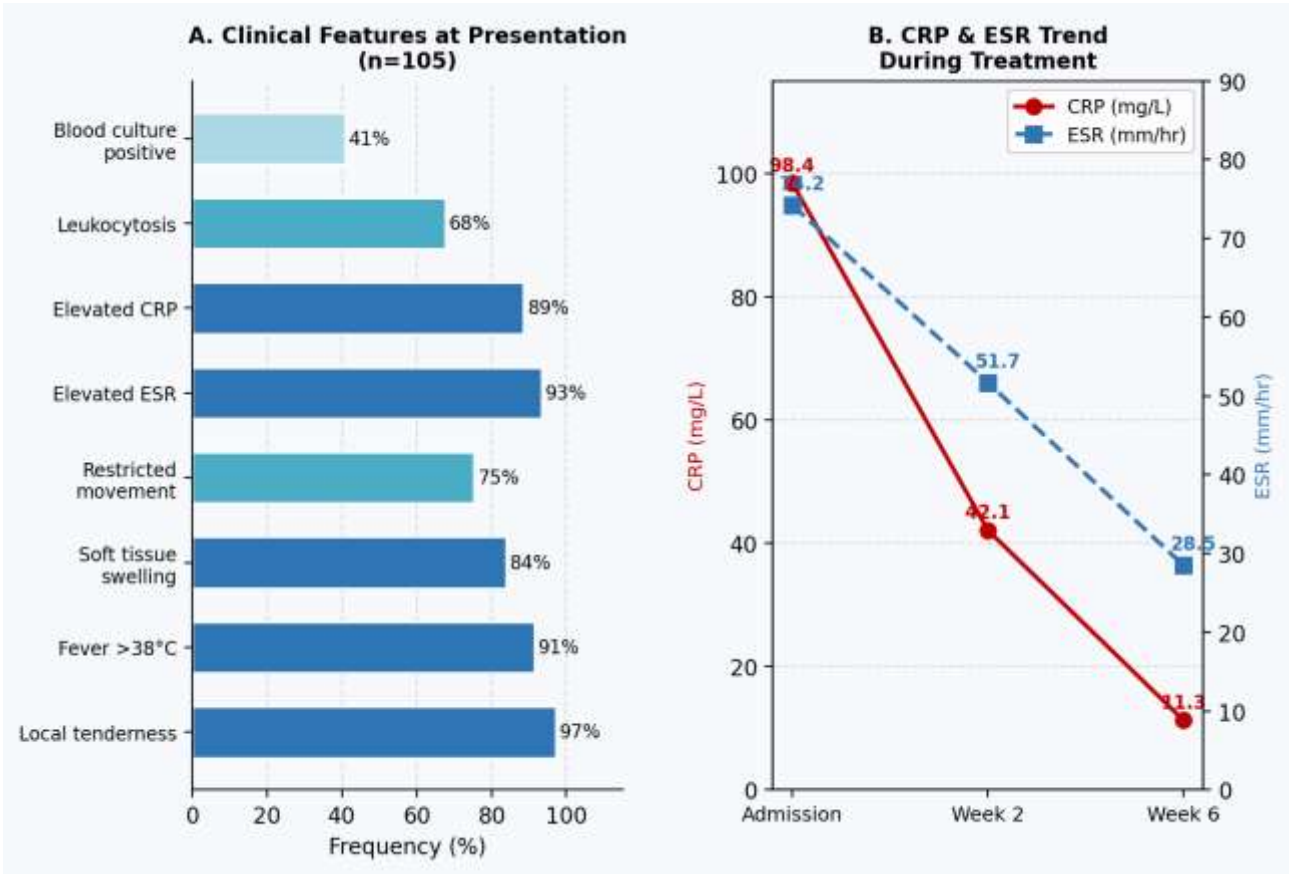


Figure 4A: Clinical features at presentation. Figure 4B: Serial CRP and ESR trends at admission, Week 2, and Week 6 of treatment. CRP demonstrated faster normalisation than ESR, making it the preferred marker for treatment monitoring.

6.6 Treatment and Outcomes

Conservative management (IV antibiotics followed by oral step-down without surgical intervention) was sufficient in 61 patients (58.1%). Surgical debridement, sequestrectomy, or drainage was performed in 44 cases (41.9%). The most common antibiotic regimen was IV Cloxacillin combined with a first-generation cephalosporin (39.0%), reflecting institutional guidelines for MSSA coverage. Vancomycin-based regimens were reserved for confirmed or strongly suspected MRSA (17.1%). Mean hospital stay was 21.0 ± 7.4 days overall, with surgical cases demonstrating longer stays (24.7 ± 8.1 days vs. 18.4 ± 6.2 days; p=0.001) (Table 3).

Table 3: Treatment Parameters and Clinical Outcomes by Management Type (n=105)

Variable	Conservative (n=61)	Surgical (n=44)	Total (n=105)	p-value
Hospital stay (days), mean±SD	18.4 ± 6.2	24.7 ± 8.1	21.0 ± 7.4	0.001*
IV antibiotics duration (days)	14.2 ± 4.1	18.6 ± 5.3	16.1 ± 4.9	0.002*
Oral antibiotics duration (wks)	4.8 ± 1.2	5.9 ± 1.6	5.3 ± 1.4	0.003*
Time to CRP normalisation (days)	28.3 ± 7.6	33.1 ± 9.2	30.3 ± 8.5	0.014*

Complications	9 (14.8%)	7 (15.9%)	16 (15.2%)	0.857
Chronic OM conversion	6 (9.8%)	4 (9.1%)	10 (9.5%)	0.892
Readmission within 3 months	3 (4.9%)	3 (6.8%)	6 (5.7%)	0.671

*Independent samples t-test; p<0.05 significant. OM = Osteomyelitis; LAMA = Left Against Medical Advice

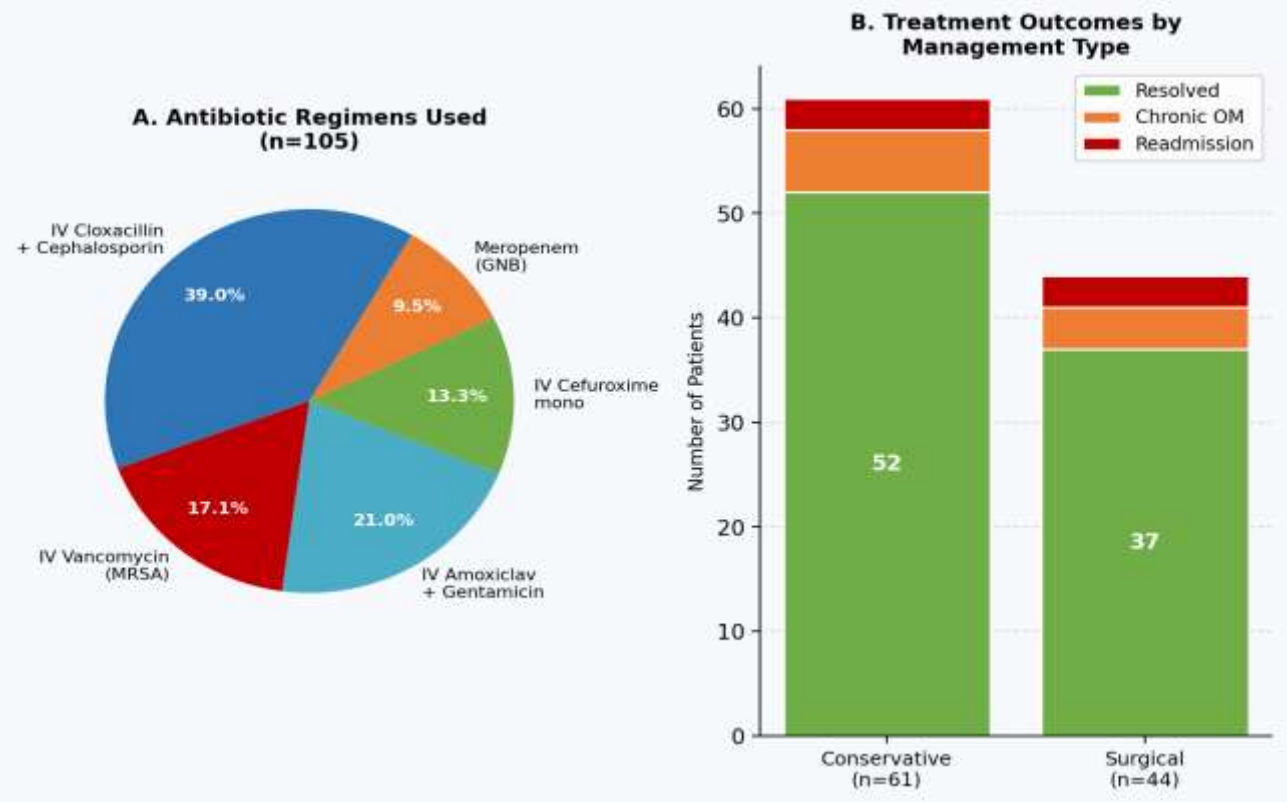


Figure 5A: Antibiotic regimens used (n=105). Figure 5B: Clinical outcomes stratified by management type. Chronic osteomyelitis conversion rate was 9.5% overall, with no statistically significant difference between conservative and surgical groups (p=0.892).

7. DISCUSSION AND INTERPRETATION

The present study provides the first structured epidemiological characterisation of paediatric osteomyelitis from a tertiary care hospital in Uttarakhand, filling an important gap in the Indian literature. The overall male predominance (66.7%) mirrors findings from comparable Indian institutional studies in Uttar Pradesh and Rajasthan,[9,13] and is broadly consistent with the hypothesis that boys sustain more minor trauma—the initiating event in haematogenous seeding—than girls of equivalent age.The age peak in the 6–10-year group (33.3%) aligns with the metaphyseal vascularity pattern unique to growing bone in this developmental window, where sluggish terminal capillary loops facilitate bacterial lodgement.[24] The secondary peak below 2 years reflects residual transphyseal vascular connections in infants, which predispose to concurrent septic arthritis—documented in 8 of our 12 infants (66.7%), a finding consistent with Bowerman et al. (2016).[25]The femoral and tibial predominance in our dataset (51.3% combined) is a near-universal feature of haematogenous osteomyelitis across global paediatric cohorts. Our findings corroborate a 2016 multicentre Indian study by Mehta et al. that reported femoral involvement in 30.1% of paediatric cases, a figure modestly exceeding ours (27.8%), possibly attributable to a higher referral volume of complex femoral infections at that institution.[6]The 41% blood culture positivity in the present study is marginally lower than the 48–52% reported in contemporary Indian studies,[9,11] which may partly

reflect the 44.8% rate of pre-admission antibiotic use observed in our cohort. The MRSA burden of 21.4% requires contextualisation: a 2018 national surveillance report from the Indian Council of Medical Research (ICMR) documented community-associated MRSA rates of 22–28% in paediatric bone infections from Northern India,[22] within which our institutional rate falls comfortably. The implication for empiric prescribing is clear: in patients with prior antibiotic exposure, persistent fever, or failed initial beta-lactam therapy, early empiric vancomycin is warranted pending culture sensitivity.The CRP-guided IV-to-oral antibiotic step-down employed in selected cases at SMIH appeared effective: among the 61 conservatively managed patients who transitioned to oral therapy at a median CRP of <40 mg/L (Day 14), only 6 (9.8%) developed chronic osteomyelitis, comparable to published Indian step-down protocols.[11] The overall chronic osteomyelitis conversion rate of 9.5% compares favourably with older Indian reports of 15–22%,[3,5] possibly reflecting improved radiological and microbiological diagnostic capability at SMIH versus peripheral facilities.
Socioeconomic class and nutritional status emerged as significant determinants of outcome ($p<0.05$ for both), consistent with the Patel Nagar and peri-urban Dehradun patient profile described by Rawat et al. (2017) in their assessment of paediatric surgical morbidity at the same institution.[4] Targeted nutritional rehabilitation and early social work referral for economically vulnerable families merit incorporation into the osteomyelitis care pathway at SMIH.

8. CONCLUSION

Paediatric osteomyelitis at SMIH, Dehradun, predominantly affects school-age males from lower socioeconomic backgrounds, with the femur and tibia as the most frequently involved sites. Staphylococcus aureus—including a clinically significant proportion of MRSA—dominates the microbiological profile, necessitating local antibiogram-guided empiric therapy. CRP-guided IV-to-oral antibiotic step-down is a feasible and effective strategy in resource-limited settings. Delayed presentation, nutritional deficiency, and socioeconomic disadvantage are independent risk factors for adverse outcomes.This study, the first of its kind from Uttarakhand, establishes a regional baseline for paediatric osteomyelitis epidemiology and provides actionable data to inform antibiotic stewardship programmes, early surgical referral criteria, and nutritional support protocols at SGRRIMHS/SMIH and similar tertiary institutions across the Himalayan foothills region.

9. LIMITATIONS OF THE STUDY

6. The retrospective design introduces data quality dependence on the completeness of case records; 7 records (6.25%) were excluded due to insufficient documentation.
7. The eight-month study window may not fully capture seasonal variation in organism prevalence or referral patterns.
8. Pre-admission antibiotic use (44.8% of cases) likely suppressed blood culture positivity, underestimating true bacteraemia rates.
9. Long-term follow-up beyond six weeks was not available in all cases, limiting assessment of functional recovery and late recurrence.
10. Absence of molecular typing for S. aureus strains precludes assessment of clonal epidemiology or virulence factor profiling.

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