Original Research Article

A Study of antibiotic susceptibility pattern of bacteria isolated from cases of skin and soft tissue infections of infants at tertiary health care center

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Abstract

Background: Skin and soft tissue infections (SSTIs) can be defined as an inflammatory microbial invasion of the epidermis, dermis and subcutaneous tissues. With knowledge of likely causative organisms causing SSTIs and their sensitivity pattern, the most suitable antibiotic can be started without waiting for the result. Therefore, present study was aimed to study antibiotic susceptibility pattern of bacteria isolated from cases of skin and soft tissue infections of infants at tertiary health care center. **Material and Methods:** Present study was hospital based observational study, conducted in children less than one year of age with clinical features suggestive of skin and soft tissue infection presented in the Out Patient Department (OPD) or In Patient Department (IPD) under Paediatric Surgery unit. **Results:** In present study 250 children were studied. Majority of them were male. Most common risk factor in this study was daily massage with oils (94.8%). Other risk factors were trauma (79.6%), body piercing (19.2%) and previous hospitalization (14%). Heat 248 (99.2%), redness 246 (98.4%) and localized swelling 240 (96%) were the commonest clinical signs present. Out of 152 bacterial isolates, 59 (38.81%) were *Staphylococcus aureus*, 25 (16.44%) were *Escherichia coli*, 14 (9.21%) were *Enterobacter* spp. and 13 (8.55%) were *Pseudomonas aeruginosa*. All gram negative bacteria other than *Pseudomonas aeruginosa* and *Acinetobacter* spp. were sensitive meropenem (96.92%), amikacin (70.76%) and imipenem (63.07%). Among *Pseudomonas aeruginosa* isolates were sensitive to imipenem (92.30%), netilmycin and meropenem (75% each). All *Acinetobacter* spp. were sensitive to higher antibiotics such as imipenem, meropenem, colistin, tigecycline and netilmycin. All the *Staphylococcus aureus* isolates were sensitive to higher antibiotics such as netilmycin, linezolid and vancomycin. **Conclusion:** All the Staphylococcus aureus isolates were sensitive to higher antibiotics such as netilmycin, linezolide and vancomycin. Streptococcus spp. were susceptible to linezolide and vancomycin. All gram-negative bacteria other than Pseudomonas aeruginosa and Acinetobacter spp. were sensitive to meropenem (96.92%), amikacin (70.76%) and imipenem (63.07%).

Keywords: SSTIs**,** Staphylococcus aureus, gram negative enteric organisms. Linezolide, meropenem

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INTRODUCTION

Skin and soft tissue infections (SSTIs) can be defined as an inflammatory microbial invasion of the epidermis, dermis and subcutaneous tissues.[1] The practice guidelines of the Infectious Diseases Society of America (IDSA) for the diagnosis and management of skin and soft tissue infections[2] classifies SSTIs into five categories, comprising superficial uncomplicated infection (includes impetigo, erysipelas and cellulitis), necrotizing infection, infections associated with bites and animal contact, surgical site infections and infections in the immune-compromised host. Human skin serves as the first line of

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defense against microbial infection as a physical barrier; by secreting low pH, sebaceous fluid and fatty acids to inhibit growth of pathogens; and by possessing its own normal flora, thus deterring colonization by other pathogenic organisms.[3] Unfortunately, having penetrated the integumentary barrier, infecting organisms may cause tissue damage and may incite an inflammatory response. Once the proper diagnosis is made, the next important step is selecting the most appropriate therapy. With this knowledge of likely causative organisms causing SSTIs and their sensitivity pattern, the most suitable antibiotic can be started without waiting for the result. This would help in avoiding unnecessary medication with ineffective antibiotics and prevent development drug resistance. Therefore, present study was aimed to study antibiotic susceptibility pattern of bacteria isolated from cases of skin and soft tissue infections of infants at tertiary health care center.

MATERIAL AND METHODS

Present study was hospital based observational study, conducted at Department of Microbiology, Lokmanya Tilak municipal Medical College Sion Mumbai, over a period of 1 year 6 months. Study was approved by institutional ethical committee.

Inclusion Criteria: Children less than one year of age with clinical features suggestive of skin and soft tissue infection presented in the Out Patient Department (OPD) or In Patient Department (IPD) under Paediatric Surgery unit

Exclusion Criteria: Patients with Hospital Acquired Infections occurring after 48 hours of admission.

A written informed consent was taken from parents. Skin and soft tissue infection was clinical. Pus or exudate was collected from the depth of the lesion by either aspiration or using at least two sterile cotton swabs after cleaning the wound with sterile normal saline and surrounding skin with alcohol. For blood culture, venipuncture site was prepared with 70% alcohol and 2% tincture iodine and 1-5 ml blood was drawn with sterile needle and syringe and transferred into the bottle containing 10-50 ml of brain heart infusion broth under aseptic precautions. Identification of isolates was done by cultural characteristics and standard biochemical tests.[4] The isolates were subjected for antibiotic susceptibility testing by employing Kirby Bauer disc diffusion technique as recommended by Clinical and Laboratory Standards Institute (CLSI)59. Patients were observed till discharge from the hospital in case admitted for the procedure for removal of pus.

Data was entered into Microsoft excel data sheet Statistical analysis was done using descriptive statistics.

RESULTS

In present study 250 children were studied. Majority of them were male (Most common risk factor in this study was daily massage with oils (94.8%). Other risk factors were trauma (79.6%), body piercing (19.2%) and previous hospitalization (14%). Heat 248 (99.2%), redness 246 (98.4%) and localized swelling 240 (96%) were the commonest clinical signs present.

Table 1: General-wise distribution

Sex	No. of cases	Percentage
Male	143	57.2
Female	107	42.8
Risk factor	No. of cases	Percentage
Animal bite	3	1.2
Trauma	199	79.6
Body piercing	48	19.2
Daily massage with oil	237	94.8
Previous hospitalization	35	14
Clinical signs	No. of cases	Percentage
Heat	248	99.2
Redness	246	98.4
Localized swelling	240	96
Localized tenderness	209	83.6
Purulent discharge	177	70.8
Fever	170	68
Abscess	74	29.6

CRP was positive in 38 (15.2%) cases and negative in majority, i.e., 212 (84.8%) of the cases. The blood culture was positive in only 32 (12.8%) cases whereas in remaining 218 (87.2%) cases it was negative. Pus culture was positive in 145 (58%) cases and there was no growth in 105 (42%) samples. In one case (0.4%) acid fast bacilli were seen. Out of 152 infections in the cases of SSTIs in present study, 74 (48.68%) were gram positive and 78 (51.31%) were gram negative bacteria. Polymicrobial infection was noted in 4 cases.

Table 2: Laboratory findings

Laboratory signs	Normal range	Mean	SD
Blood culture Positive	32	12.8	
Pus culture Positive	145	58	
AFB positive	1	0.4	
Gram reaction			
Gram positive	74	48.68	
Gram negative	78	51.31	

Out of 152 bacterial isolates, 59 (38.81%) were *Staphylococcus aureus*, 25 (16.44%) were *Escherichia coli*, 14 (9.21%) were *Enterobacter* spp. and 13 (8.55%) were *Pseudomonas aeruginosa*. Of the 74 gram positive organisms, 59 (79.72%) were *Staphylococcus aureus*, 5 (6.75%) were *Streptococcus* spp., 6 (8.13%) were Micrococci, 3 (4.05%) were Diphtheroids and one (1.35%) was *Enterococcus* spp Among all the gram negative organisms (n=78) isolated, *Escherichia coli* were the commonest (32.05%) followed by *Enterobacter* spp. (17.94%), *Pseudomonas aeruginosa* (16.66%), *Klebsiella pneumoniae*. and *Acinetobacter* spp. (14.10% each) and *Citrobacter* spp., *Proteus mirabilis* and *Serratia* spp. (1.28% each). The Micrococci and Diphtheroids were considered as commensals and not processed further.

Table 3: Frequency of Microorganisms isolated

Organisms	Frequency	Percentage
Gram positive (n=74)		
Staphylococcus aureus	59	79.72
MRSA	33	55.93
MSSA	26	44.06
Streptococcus spp.	05	6.75
Enterococcus spp.	01	1.35
Micrococcus	06	8.13
Diphtheroids	03	4.05
Gram negative (n=78)		
Escherichia coli	25	32.05
Enterobacter spp.	14	17.94
Pseudomonas aeruginosa	13	16.66
Klebsiella pneumoniae.	11	14.10
Acinetobacter spp.	11	14.10
Citrobacter spp.	01	1.28
Proteus mirabilis	01	1.28
Serratia spp.	01	1.28
Mixed growth	04	5.12

All gram negative bacteria other than *Pseudomonas aeruginosa* and *Acinetobacter* spp. were sensitive to higher antibiotics such as colistin and tigecycline. Majority of the isolates were sensitive to meropenem (96.92%), amikacin (70.76%) and imipenem (63.07%). Amoxycillin-clavulanic acid (4.61%) and piperacillin (13.84%) were the least susceptible antibiotics.

Table 4: Antibiotic susceptibility pattern of Gram Negative organisms (n=65) (except *Pseudomonas aeruginosa* and *Acinetobacter* spp.)

Antibiotics	Sensitive	Resistant
Amikacin	46 (70.76%)	19 (29.23%)
Amoxycillin-clavulanic acid	03 (4.61%)	62 (95.38%)
Ciprofloxacin	25 (38.46%)	40 (61.53%)
Cefotaxime	12 (18.46%)	50 (76.92%)
Cefazolin	10 (15.38%)	55 (84.61%)
Piperacillin	09 (13.84%)	56 (86.15%)
Meropenem	63 (96.92%)	02 (3.07%)
Piperacillin-tazobactam	16 (24.61%)	49 (75.38%)
Netilmycin	33 (50.76%)	32 (49.23%)
Imipenem	41 (63.07%)	24 (36.92%)
Cefepime	21 (32.30%)	44 (67.69%)
Colistin	65 (100%)	00 (0%)
Tigecycline	65 (100%)	00 (0%)

Among the 13 isolates of *Pseudomonas aeruginosa*, 12 (92.30%) isolates were sensitive to imipenem. Higher antibiotics such as netilmycin and meropenem were susceptible to most of the strains (75% each).

Table 5: Antibiotic susceptibility pattern of *Pseudomonas aeruginosa* isolates(n=13)

Antibiotics	Sensitive	Resistant
Gentamicin	7 (53.84%)	6 (46.15%)
Ceftazidime	6 (46.15%)	7 (53.84%)
Ofloxacin	7 (53.84%)	6 (46.15%)
Piperacillin	8 (61.53%)	5 (38.46%)
Imipenem	12 (92.30%)	1 (7.69%)
Piperacillin-tazobactam	2 (50%)	2 (50%)
Netilmycin	3 (75%)	1 (25%)
Meropenem	3 (75%0	1 (25%)
Aztreonam	1 (25%)	3 (75%)

All *Acinetobacter* spp. were sensitive to higher antibiotics such as imipenem, meropenem, colistin, tigecycline and netilmycin. Among other antibiotics the isolates were sensitive to piperacillin-tazobactam (63.63%) followed by ampicillin-sulbactam and cefepime (54.54% each). The isolates were resistant to amoxicillin-clavulanic acid, Cefotaxime, ceftazidime and co-trimoxazole. They were least sensitive to amikacin and ciprofloxacin (18.18% each).

Table 6: Antibiotic susceptibility pattern of *Acinetobacter* spp. isolates (n=11)

Antimicrobial agents	Sensitive	Resistant
Amikacin	02 (18.18%)	09 (81.81%)
Amoxycillin-clavulanic acid	00 (0%)	11 (100%)
Ciprofloxacin	02 (18.18%)	09 (81.81%)
Cefotaxime	00 (0%)	11 (100%)
Ceftazidime	00 (0%)	11 (100%)
Piperacillin	01 (9.09%)	10 (90.90%)
Meropenem	11 (100%)	00 (100%)
Piperacillin-tazobactam	07 (63.63%)	04 (36.36%)
Netilmycin	11 (100%)	00 (0%)
Imipenem	11 (100%)	00 (0%)
Cefepime	06 (54.54%)	05 (45.45%)
Ampicillin-sulbactam	06 (54.54%)	05 (45.45%)
Co-trimoxazole	00 (0%)	11 (100%)
Colistin	11 (100%)	00 (0%)
Tigecycline	11(100%)	00 (0%)

All the *Staphylococcus aureus* isolates were sensitive to higher antibiotics such as netilmycin, linezolid and vancomycin. Majority of the isolates were sensitive to clindamycin (83.05%) followed by gentamicin (76.27%), erythromycin (61.01%) and ciprofloxacin (44.06%).

Table 7: Antibiotic susceptibility pattern of *Staphylococcus aureus* isolates (n=59)

Antimicrobial agents	Sensitive	Resistant
Gentamicin	45 (76.27%)	14 (23.72%)
Penicillin-G	03 (5.08%)	56 (94.91%)
Cefoxitin	26 (44.06%)	33 (55.93%)
Ciprofloxacin	34 (57.62%)	25(42.37%)
Co-trimoxazole	24 (40.67%)	35 (59.32%)
Erythromycin	36 (61.01%)	23 (38.98%)
Clindamycin	49 (83.05%)	10 (16.94%)
Linezolid	59 (100%)	00 (0%)
Vancomycin	59 (100%)	00 (0%)
Netilmycin	59 (100%)	00 (0%)

All the five isolates of *Streptococcus* spp. were susceptible to linezolid and vancomycin. Penicillin-G (20%), erythromycin (20%) and clindamycin (40%) were the least susceptible antibiotics.

Table 8: Antibiotic susceptibility pattern of *Streptococcus* spp.

Antimicrobial	Sensitive	Resistant
Penicillin-G	1 (20%)	4 (80%)
Erythromycin	1 (20%)	4 (80%)
Clindamycin	2 (40%)	3 (60%)
Cefotaxime	3 (60%)	2 (40%)
Vancomycin	5 (100%)	0 (0%)
Linezolid	5 (100%)	0 (0%)

DISCUSSION

Skin and soft tissue infections (SSTIs) are suppurative microbial invasions of the epidermis, dermis and subcutaneous tissues characterized by induration, erythema, warmth, and pain or tenderness. Local manifestations may be accompanied by systemic signs and symptoms, such as fever, chills, malaise and, at times, haemodynamic instability. Systemic signs include hypotension and associated findings consistent with severe sepsis/septic shock including mental obtundation, cardiovascular and/or pulmonary collapse among other organ system failures. Emergency department (ED) visits for skin and soft tissue infections in children have increased dramatically in the last decade.[5] Accordingly, from 1997 to 2009, hospital admission for pediatric patients with skin and soft tissue infections increased from 1.9 to 3.4 million annually.[6] During that same time, pediatric patients requiring incision and drainage have doubled.[6] This growing volume of patients is thought to be largely due to the emergence of community-acquired methicillin-resistant Staphylococcus aureus (CA-MRSA). In the present study, majority of patients were male. In several other studies conducted by Ghadage DP *et al.*[7] and Andrews RM *et al.*[8] similar pattern of gender distribution was found. In present study most common risk factor was daily massage with oils (94.8%). Other risk factors were trauma (79.6%), body piercing (19.2%) and previous hospitalization (14%). None of the case had history of attending day care center, diabetes or presence of some other risk factor. Natural vegetable or plant oils (for example, mustard, sunflower, sesame, coconut, olive, and soybean oils) have emollient properties and in many low- and middle-income countries application of these to the newborn infant's whole body surface is a widespread traditional practice.[9] But, topical application of oils has not been shown to reduce the risk of infection or its associated morbidity or mortality, and may increase the risk of infection with coagulase-negative staphylococci in a study by Cleminson *et al.*[9] Out of 156 cases, 152 (97.43%) were monomicrobial and 4 (2.56%) were polymicrobial infections. Among 152 monomicrobial infections, 74 (48.68%) were gram positive and 78 (51.31%) were gram negative bacteria. In a study by Rani *et al.*[10] 90% cases yielded growth of bacteria, out of which 71.85% were monomicrobial and 28.14% were polymicrobial infections. Of the 152 bacterial isolates in present study, 59 (38.81%) were Staphylococcus aureus, 25 (16.44%) were Escherichia coli, 14 (9.21%) were Enterobacter spp. and 13 (8.55%) were Pseudomonas aeruginosa. Mohanty *et al.*[11] reported Staphylococcus aureus(38.05%), Escherichia coli(17.39%) and Pseudomonas aeruginosa(11.82%) as the top three isolates in their study. They have reported incidence of Enterobacter spp. as 2.80% in their study. Zargar *et al.*[12] from India and Rennie *et al.*[13] and Sader *et al.*[14] also reported these organisms among top five pathogens isolated from skin and soft tissue infections in hospitalized patients. In present study, resistance to methicillin was detected in 33 (55.93%) of Staphylococcus aureus isolates. MRSA is on the rise in SSTIs in children both in the hospital setup (HA-MRSA) and in the community. Prevalence of MRSA was found to be consistent with studies by Gupta *et al.*(54.5%)[15],Anupurba *et al.*(54.8%)[16] and by Roveta *et al.*(53%)[17]. All the Staphylococcus aureus isolates (n=59) were sensitive to higher antibiotics such as netilmycin, linezolid and vancomycin. Majority of the isolates were sensitive to clindamycin (83.05%) followed by gentamicin (76.27%), erythromycin (61.01%) and ciprofloxacin (44.06%), whereas, maximum resistance was seen to penicillin (95%). This is in correlation with the study of Thind *et al.*[18] where Staphylococcus aureus showed 100% resistance to penicillin and 100% sensitivity to vancomycin, teicoplanin and linezolid. Ramana *et al.*[19], Nagaraju *et al.*[20], Patil *et al.*[21] and Singh *et al.*[22] observed a similar high resistance of Staphylococcus aureus to penicillin. All gram negative bacteria other than Pseudomonas aeruginosa and Acinetobacter spp. were sensitive to higher antibiotics such as colistin and tigecycline. Majority of the isolates were sensitive to meropenem (96.92%), amikacin (70.76%) and imipenem (63.07%). Amoxycillin-clavulanic acid (4.61%) and piperacillin (13.84%) were the least susceptible antibiotics. Resistance of Gram negative organisms was minimum against meropenem, imipenem and amikacin which is similar to other studies.[23,24] The susceptibility data collected in this study suggests that the most common organisms likely to be encountered in soft tissue infections are gram-positive cocci, notably Staphylococcus aureus, many of them methicillin-resistant. Thus, any first line antibiotic treatment should be primarily directed against this pathogen. For coverage of gram negative bacteria, aminoglycosides, meropenem and imipenem would be more useful. Use of mono drug therapy with cephalosporins, aminoglycosides and fluoroquinolones need to be guided by the sensitivity report. Lastly, continued monitoring of susceptibility pattern need to be carried out in individual settings so as to detect the true burden of antibiotic resistance in organisms and prevent their further emergence by judicious use of drugs.

CONCLUSION

In present study the main pathogens involved in these infections are Staphylococcus aureus and gram negative enteric organisms. All the Staphylococcus aureus isolates were sensitive to higher antibiotics such as netilmycin, linezolide and vancomycin. Streptococcus spp. were

susceptible to linezolide and vancomycin. All gram negative bacteria other than Pseudomonas aeruginosa and Acinetobacter spp. were sensitive to meropenem (96.92%), amikacin (70.76%) and imipenem (63.07%). Increasing antibacterial resistance is becoming a major problem in the treatment of these infections worldwide. Continued monitoring of susceptibility pattern need to be carried out in individual settings so as to detect the true burden of antibiotic resistance in organisms.

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