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A study of pattern of skin and soft tissue infections in infants attending the pediatric surgery department at a tertiary care hospital

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Abstract

Background: SSTIs are inflammatory microbial invasion of the epidermis, dermis and subcutaneous tissues. According to the setup from where the infection is contacted, it may be 'community acquired' (CA) or 'hospital acquired/ nosocomial' (HA) infection. The former usually involves a single pathogen, whereas the latter is often polymicrobial. Majority of SSTIs are caused by bacteria and are referred to as acute bacterial skin and skin structure infections **Methodology**- This study was undertaken at Department of Microbiology of a Tertiary care hospital over a period of 1 year 6 months. In this study, 250 children of 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 were included. Diagnosis of skin and soft tissue infection was made on the basis of clinical features. Identification of isolates was done by cultural characteristics and standard biochemical tests. **Results-** In present study the main pathogens involved in these infections are Staphylococcus aureus and gram-negative enteric organisms. All gram-negative bacteria were sensitive to higher antibiotics. Among other antibiotics the isolates were sensitive to piperacillin-tazobactam (63.63%) followed by ampicillin-sulbactam and cefepime. **Conclusion-** With the knowledge of likely causative organisms causing SSTIs and their sensitivity pattern, the most suitable antibiotic can be started without waiting for the result.

Keywords: Skin, soft tissue infection, blood, pus, bacteria

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Introduction

Skin and soft tissue infections (SSTIs) are clinical entities of variable presentation, etiology and severity that involve microbial invasion of the layers of the skin and underlying soft tissues. SSTIs can be defined as an inflammatory microbial invasion of the epidermis, dermis and subcutaneous tissues.[1] It can be classified as 'superficial' (epidermis and dermis) and 'deep' (hypodermis, fascia and muscle).[2] According to the setup from where the infection is contacted, it may be 'community acquired' (CA) or 'hospital acquired/ nosocomial' (HA) infection. The former usually involves a single pathogen, whereas the latter is often polymicrobial. Majority of SSTIs are caused by bacteria are referred to as acute bacterial skin and skin structure infections. Bacterial skin and skin structure infections commonly encountered in children include impetigo, folliculitis, furunculosis, carbuncles, wound

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infections, abscesses, cellulitis, erysipelas, and staphylococcal scalded skin syndrome. Poor hygiene, physical contacts and crowded conditions in day care centers facilitate the spread of contagious infections such as furuncles, carbuncles, and impetigo. Poorly controlled diabetes often leads to infections. Traumatic events such as cuts and animal bites and ear piercing result in wounds that increase the risk of skin infections and abscesses.[3] The predominance of Gram positives over the Gram negatives as the cause of SSTI is in fact a solace at a time when the Gram negative pipeline is getting drier and the Gram positive one is still flowing at full velocity and vigor. This depicts the importance of early diagnosis and correct management of the broad spectrum of SSTI, ranging from simple boils to life threatening necrotising fasciitis.

Once the proper diagnosis is made, the next important step is selecting the most appropriate therapy. In children presenting with mild or moderately severe bacterial skin and skin structure infections and not requiring inpatient management or urgent operative debridement, prompt provision of oral antimicrobial therapy avoids the risk of worsening infection or hospitalization. Empiric antimicrobial therapy should be directed at the most likely pathogens, (e.g. *Staphylococcus aureus* or *Streptococcus pyogenes*), although some infections (e.g. subcutaneous abscesses and cellulitis following animal or human bites) may have a polymicrobial origin. If diagnosed early and treated appropriately, these infections are almost always curable, but some have the potential to cause serious complications such as septicemia, nephritis, carditis and arthritis if diagnosis is delayed and/or treatment is inadequate. Therefore, this study was undertaken to study the pattern of microbial spectrum in infants.

Materials And Methods

This prospective study was conducted at Department of Microbiology of a Tertiary care hospital over a period of 1 year 6 months. The sample size taken for this study was 250 children. Children less than one year of age with clinical features suggestive of skin and soft tissue infection were included for the study. Those who had Hospital Acquired Infections occurring after 48 hours of admission were excluded from the study.

At the initiation of the study a diagnosis of skin and soft tissue infection was made on the basis of following clinical features such as local signs of redness, warmth, swelling, pain with or without dysfunction, with presence of bullae, haemorrhage, rapidly progressive in nature, crepitus. Venipuncture site was prepared with 70% alcohol and 2% tincture iodine. 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. The specimens were transported to the Microbiology Laboratory immediately. The blood that was sent in brain heart infusion broth was incubated at 37^{o}C for 24 hours. Subculture was done on Blood agar and MacConkey's agar after 24-hours incubation. These plates were incubated at 37^{o}C for 24 hours. If no growth, subculture was repeated for 5 days. 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). Patients were observed till discharge from the hospital in case admitted for the procedure for removal of pus.

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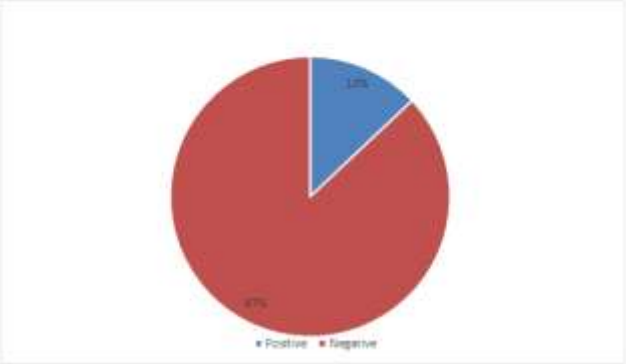
Results

Table 1: Laboratory signs of SSTIs cases

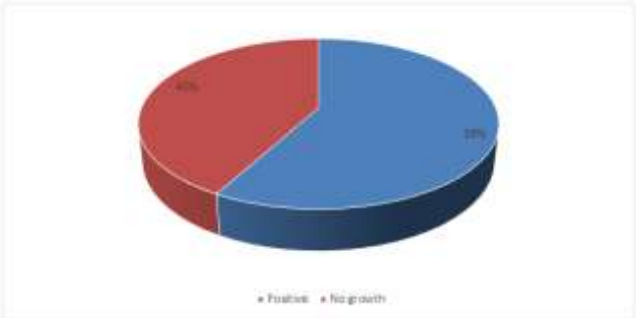
Laboratory signs	Normal range	Mean	SD
Hb (gm/dl)	10 – 16	10.86	0.86
TLC (per mm^3)	6000-10000	6404.24	1133.47
Platelet count (per µl)	150000-400000	249500	79661.8
BSL (mg/dl)	60- 100	81.54	9.97
Serum Sodium (mEq/L)	135-145	139	0.86
Serum potassium (mEq/L)	3.5-5.0	4.01	0.20
Total protein (g/dl)	5.5-7.5	4.78	0.31
Albumin (g/dl)	3.6-5.1	3.04	0.21
Globulin (g/dl)	2.0-3.8	1.71	0.30
A/G ratio	0.8-2.0	1.64	0.29

Routine laboratory investigations were done in all cases of SSTIs to predict the risk of development of fulminant soft tissue infection. It was found that all laboratory values were within normal ranges and none of the patient had a risk of development of life threatening infection. (Table 1)



Graph 1: Blood culture in SSTIs cases

In all 250 cases of SSTIs, blood culture was done. The blood culture was positive in only 32 (12.8%) cases whereas in remaining 218 (87.2%) cases it was negative (GRAPH 1). These cases belong to Class 3 of Erons classification of SSTIs.



Graph 2: Pus culture in SSTIs cases

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Pus aspirate and in few cases pus swabs were collected and grown on routine culture media. Pus culture was positive in 145 (58%) cases and there was no growth in 105 (42%) samples (GRAPH 2).

Table 2: Gram positive and negative bacteria isolated from SSTIs cases (n=152)

Gram reaction	Frequency	Percentage
Gram positive	74	48.68
Gram negative	78	51.31

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).

Table 3: Frequency of Microorganisms isolated

Organisms	Frequency	Percentage
Gram positive (n=74)		
Staphylococcus aureus	59	79.72
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

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. The Micrococci and Diphtheroids were considered as commensals and not processed further.

Among all the gram negative organisms (n=78) isolated, *Escherichia coli* were the commonest (32.05%) followed by *Enterobacter* spp. (17.94%), Pseudomonas aeruginosa .(Table 3)

Table 4: Distribution of Methicillin Resistant and Sensitive isolates

Staphylococcus aureus	**Frequency**	**Percentage**
MRSA	33	55.93
Pus culture	26	78.78
Blood culture	07	21.21
MSSA	26	44.06
Pus culture	20	76.92
Blood culture	06	23.07

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Among 59 *Staphylococcus aureus* isolates, 33 (55.93%) were found to be methicillin resistant and 26 (44.06%) were methicillin sensitive. Out of 33 total MRSA isolates, 26 were from pus culture and 7 were from blood culture. In MSSA also, majority of the isolates were from pus culture. (Table 4)

Table 5: Antibiotic susceptibility pattern of Gram Negative organisms (n=65)

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%)
Cefotaxim	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%)
Higher antibiotics		
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%)

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 5)

Table 6: 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%)
Higher antimicrobial		
Linezolid	59 (100%)	00 (0%)
Vancomycin	59 (100%)	00 (0%)
Netilmycin	59 (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 6).

Table 7: Antibiotic susceptibility pattern of *Streptococcus* Spp. *Streptococcus* spp. (n=5)

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

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Vancomycin	5 (100%)	0 (0%)
Linezolid	5 (100%)	0 (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 7).

Table 8: Antibiotic susceptibility pattern of *Enterococcus* Spp. *Enterococcus* spp. (n=1)

Antimicrobial	Sensitive	Resistant
Penicillin-G	0 (0%)	**1 (100%)**
Vancomycin	1 (100%)	**0 (0%)**
Linezolid	1 (100%)	**0 (0%)**
Ampicillin	0 (0%)	**1 (100%)**
High level Streptomycin	1 (100%)	**0 (0%)**
High level Gentamicin	0 (0%)	**1 (100%)**

Only one *Enterococcus* spp. was isolated in the present study, which was found to be resistant to high level gentamicin and sensitive to high level streptomycin, linezolid and vancomycin. (Table 8).

Discussion

In present study, all laboratory values were within normal ranges and none of the patient had a risk of development of life-threatening necrotizing soft tissue infection. Clinical diagnosis based on signs and symptoms on presentation is not reliable since early signs of necrotizing soft tissue infections are the same as those seen with non-necrotizing infections and hard signs are variable and only present in a minority of patients. A study by Wall *et al.*[5] compared admission variables between patients with necrotizing soft tissue infections and those with non-necrotizing soft tissue infections. After univariate and multivariate analyses, they created a model that was able to accurately predict necrotizing soft tissue infections in their population of patients. Those patients with either a white blood cell (WBC) count > 15,400 or a serum Na level <135 mmol/L were at higher risk of having a necrotizing soft tissue infections. The model is very sensitive but not very specific with a negative predictive value (NPV) of 99% and a positive predictive value (PPV) of only 26%. Clearly it is a valuable tool when negative (rules out necrotizing soft tissue infections) but when it is positive it does not confirm the diagnosis.

In present study, out of 250 cases, blood culture was positive in only 32 (12.8%) cases and pus culture was positive in 145 (58%) cases. Overall, 156 (62.4%) cases yielded growth on culture media while 104 (41.6%) were sterile.

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.*[6] 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.*[7] 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.*[8] from India and Rennie *et al*.[9] and Sader *et al*.[10] from outside also reported these organisms among top five pathogens isolated from skin and soft tissue infections in hospitalized patients. *Staphylococcus aureus* is the almost-universal cause of furuncles, carbuncles, and skin abscesses and worldwide is the most commonly identified agent

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responsible for skin and soft tissue infections. The typical organisms that colonize the skin above the waist are usually Gram-positive species such as *Staphylococcus epidermidis*, *Corynebacterium* species, *Staphylococcus aureus* and *Streptococcus pyogenes*. The latter two species are particularly significant because they contribute to a majority of SSTIs.

Staphylococcus aureus was the commonest isolate in our study. Many other investigators such as Ghadage *et al.*[11] Mohanty *et al.*[7] Mathew *et al.*[12] Baslas *et al.*[13] Ahmed *et al*.[14] and Sugeng *et al.*[15] have similarly found *Staphylococcus aureus* to be the major isolate in pediatric 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%),[16]Anupurba *et al.* (54.8%)[17] and by Roveta *et al.* (53%).[18]

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.*[19] where *Staphylococcus aureus* showed 100% resistance to penicillin and 100% sensitivity to vancomycin, teicoplanin and linezolid. Ramana *et al.*[20] Nagarajun *et al.*[21] Patil *et al.*[22] and Singh et al[23] observed a similar high resistance of *Staphylococcus aureus* to penicillin.

As regards to Streptococci, all the five isolates were susceptible to linezolid and vancomycin. Penicillin-G, erythromycin and clindamycin were the least susceptible antibiotics to the Streptococci isolates. Only one *Enterococcus* spp. was isolated in the present study, which was found to be resistant to high level gentamicin and sensitive to high level streptomycin, linezolid and vancomycin. All gram negative bacteria 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.[24-26]

Conclusion

In present study most of the patients belongs to the Class 1 and Class 2 of Erons classification if SSTIs. Maximum number of CRP positive and blood culture positive cases belongs to Class 3 of Erons classification of SSTIs.

In present study the main pathogens involved in these infections are *Staphylococcus aureus* and gram-negative enteric organisms. Among 59 *Staphylococcus aureus* isolates, 33 (55.93%) were found to be methicillin resistant and 26 (44.06%) were methicillin sensitive. All the *Staphylococcus aureus* isolates were sensitive to higher antibiotics such as netilmycin, linezolide and vancomycin. *Streptococcus* spp. were susceptible to linezolide and vancomycin. *Enterococcus* spp. was sensitive to high level streptomycin, linezolide and vancomycin. 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%). 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). 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). Increasing antibacterial

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resistance is becoming a major problem in the treatment of these infections worldwide. Especially in the era of increasing antimicrobial resistance, knowledge of local resistance patterns will help guide therapeutic decisions. Thus, 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. 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.

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