Journal of Pakistan Association of Dermatologists. 2020; **30(4)**: 580-586.

Original Article

Bacteriological profile and antibiotics susceptibility patterns of complicated skin and skin structure infections in tertiary care hospitals, Peshawar

Aiman Waheed, Ali Amar*, Irfanullah Afridi, Sadaf Rauf, Mehran****

Department of Biotechnology and Microbiology, University of Peshawar.
* Department of Dermatology, PAF Hospital, Jacobabad.
** Department of Dermatology, Khyber Teaching Hospital, Peshawar.

Abstract

Objective To identify various isolates causing complicated skin and skin structure infections with their antibiotic susceptibility patterns.

Methods A total of 436 samples of pus/ discharge from skin lesions were collected and cultured. Bacterial colonies were identified by using gram stain and biochemical test. Kirby-Bauer disc diffusion technique was followed for testing antibiotics susceptibility patterns.

Results The most commonly affected age group observed in the present study was 15-44 years (44.03%). The predominant Gram-positive bacteria was *Staphylococcus aureus* and gram negative was *Escherichia coli*. 20 (19.60%) of *S. aureus* and 22 (40.74%) of Coagulase negative Staphylococci (CONS) were methicillin resistant. Vancomycin was found as most efficient drug followed by Fusidic acid, linezolid, Amikacin chloramphenicol and gentamicin in case of gram positive isolates. Tigecycline was found as most efficient drug as all isolates were found susceptible to it. Incase of gram negative isolates, maximum resistance was shown to cephalosporin, ampicillin, erythromycin and co-trimoxazole while least resistance was recorded against Ticarcillin, Tazobactam-pipiracillin, amikacin and gentamicin.

Conclusion Vancomycin, tigecycline, amikacin, gentamicin and fusidic acid showed more efficacy in the present study.

Key words
Bacteriological profile, antibiotics susceptibility, skin infections.

Introduction

The Complicated skin and skin structure infection (CSSSIs) outspread to the hypodermic soft tissue or muscle and need aggressive treatment. The response to the therapy is complicated due to nature of disease condition.[1] CSSSI might be interrelated with a diverse etiology including gram negative and gram positive microbes such as *S. aureus*, β hemolytic streptococci, enterococci, *Escherichia coli, and Pseudomonas aeruginosa*.[2] Evaluation of the prevalence and incidence of SSTIs has been difficult due to their variable presentations. The expected prevalence ratio of SSTIs is 24.6 per 1000 person-years.[3] The estimated prevalence of SSTI is varying due to the reason that most of them tend to resolve within seven to ten days. The expected incidence of SSTIs among hospitalized patients is 7% to 10%.[4,5] SSTIs are frequently found among patients between 45 and 64 years of age and men (60% to 70% of all cases).[3] CSSSI frequently involves intravenous antibiotic treatment, surgical involvement, or

Address for correspondence
Dr. Irfanullah Afridi
Department of Dermatology,
Khyber Teaching Hospital, Peshawar.
Email: drirfanafridi82@yahoo.com

both.[6] Efficient antibiotic chemotherapies are particularly limited at the present time due to the appearance of the drug-resistant Gram-positive and multi drug-resistant Gram-negative bacteria[7]. The CSSSIs mostly come across in health care setting and are treated by 1st generation Cephalosporin and penicillinase resistant penicillins for Group A Streptococcus and Methicillin Sensitive *S. aureus* (MSSA).[8] The increase in CSSSIs is related with the rise in the frequency of Methicillin Resistant *S. aureus* (MRSA).[9]

It is therefore essential to observe the antibiotics resistance profile and the alterations in bacterial infections in order to suggest the suitable treatment to control the infection at time, prevent the spread of infection to other body parts and to improve the life quality. Subsequently in our hospital settings an inadequate amount of data is available regarding CSSSI, antibiotic susceptibility patterns of bacteria and mortality rate; this study aims to determine the microbiological profile, prevalence and antibiotics susceptibility patterns of bacteria isolated from CSSSI samples.

Methods

A hospital based, prospective cross sectional study of eight months was conducted in Khyber Teaching Hospital and Hayatabad Medical Complex, Peshawar from June 2019 to February 2020 by permission of institutional ethical committee.

Patients of all ages and gender having skin infection were included in the study while those that were already on systemic or topical antibiotics were excluded. All relevant samples were collected as per hospital sample collection protocol from infected areas. All pus/ wound swab samples were processed as per standard microbiology laboratory operating guidelines.[10,11] Isolates were generally identified up to species level by means of various biochemical tests. Susceptibility tests were performed as per Clinical Laboratory Standards Institute (CLSI, USA) guidelines 2012.[12] The antibiotics of different groups were used such as: Penicillins i.e. Ampicillin [AMP] (30µg) and amoxicillin-clavulanic acid [AMC] (5 µg), Cephalosporins i.e. Cephradine [CE] (30 µg), Cefaclor [CEC] (30 µg), Ceftazidime [CAZ] (30 µg), Cefixime [CFM] (5 µg), Cefepime {FEP} (30 µg), Cefpirome [CPO] (30 µg), Ciprofloxacin [CIP] (5 µg), Cefotaxime [CT] (30 µg) and Cefoxitin [FOX] (30 µg), Macrolides i.e. Erythromycin [E] (15 µg) and Clarithromycin [CLR] (15 µg), Meropenem [MEM] (10 µg) of Carbapenem group, Aminoglycosides i.e. Gentamicin [CN] (10 µg) and Amikacin [AK] (30 µg), Doxycycline [DO] (30 µg) from Tetracycline group, Trimethoprim+Sulphamethoxazole [SXT] (25/23.75 µg) from sulpha drugs, Glycopeptides like Vancomycin [VA] (30 µg), Tigecycline [TGC] (15 µg) of Glycycline group, Antituburcular like Rifampicin [RD] (5 µg) and others include Novobiocin [NV] (5 µg), Aztreonem [AZM] (15 µg), clindamycin [DA] (2 µg), linezolid [LZD] (30 µg), Fusidic acid [FD] (10 µg), Chloramphenicol [C] (30 µg), Ticarcillin [TIC] (75 µg), and Pipiracillin+tazobactam [TZP] (40 µg).

Results

In the present study 436 cases were included, 254 (58.25%) were males and 182 (41.74%) were females with a ratio of 1.39:1. There was only one patient in age group of under one year, 90 (20.64%) cases were in the age group of 1-14 years, 192 (44.03%) in 15-44 years age group, 102 (23.39%) cases were in 45-64 years group and 51 (11.69%) cases were from the patients of

Table 1 Distribution of CSSSI with age.

Type of infection	*Age groups in years*					*Total*	
	<1	*1-14*	*15-44*	*45-64*	*>65*	*No.*	*%*
Abscess	1	18	44	23	20	106	24.31
Skin ulcer	-	23	29	15	7	74	16.97
Furunculosis	-	2	41	18	9	70	16.05
Folliculitis	-	11	24	10	3	48	11
Cellulitis	-	4	16	18	8	46	10.55
Impetigo	-	30	6	-	-	36	8.25
Carbuncles	-	1	14	8	1	24	5.50
Fournier's gangrene	-	1	11	6	2	20	4.58
Necrotizing fasciitis	-	-	7	4	1	12	2.75
Total	1	90	192	102	51	436	100

Table 2 Bacteria isolated from samples.

Bacteria	*n*	*%*
Gram positive isolates		
Staphylococcus aureus	92	25
CONS	32	8.69
MRCONS	22	5.97
MRSA	20	5.43
Streptococci	16	4.34
Gram negative isolates		
Escherichia coli	60	16.34
Pseudomonas aeruginosa	48	13.04
Enterobacter spp.	44	11.95
Streptococci	16	4.34
Proteus mirabilis	16	4.34
Citrobacter spp.	12	3.26
Morganella spp.	10	2.71
Klebsiella pneumoniae	8	2.17

CONS: Coagulase Negative *Staphylococci*, MRCONS: Methicillin Resistant Coagulase Negative *Staphylococci*, MRSA: Methicillin Resistant *Staphylococcus aureus, spp.:* species

age 65+ years. Abscesses were found as most common type of infection followed by skin ulcers and others as shown in **Table 1**.

Among collected samples, 352 (80.73%) cases were found culture positive while 84 (19.26%) were negative. 336 (77.06%) showed growth for single pathogen while multiple growth was observed in 16 (3.66%) cases. The bacterial isolates were assigned to ten bacterial species on the basis of morphological features, culture characteristics, gram stain and biochemical characterization as shown in **Table 2**.

All the gram positive isolates were found susceptible to Vancomycin. *S. Aureus* were found susceptible to most of the antibiotics, MRSA showed increased resistance to most of the antibiotics tested, CONS were found resistant to ampicillin, amoxicillin, doxycycline, erythromycin, ciprofloxacin, co-trimoxazole, Streptococci were found susceptible to almost all of antibiotics and MRCONS were found resistant to most of the antibiotics tested as shown in **Table 3**.

Gram negative isolates were found resistant to most of the antibiotics tested. Tigecyline was found as most efficient drug because all the isolates were found susceptible to it. Maximum resistance was recorded against ampicillin, amoxicillin, ciprofloxacin, Cephradine, Cefaclor, Ceftazidime, Cefixime, cefepime, cefotaxime and erythromycin while most of the isolates were found susceptible to meropenem, gentamicin, Amikacin, tazobactam+ pipiracillin, Ticarcillin, chloramphenicol and clarithromycin as shown in **Table 4**.

Discussion

In present study, males (58.25%) were affected more as compared to females and the most common age group was 15-44 years (44.03%) which is comparable to the studies of Malhotra *et al.*, N. Sowmya and S. Savitha *et al*.[13,14]

In comparison to other studies, most of the samples in our study were mono-microbial

Table 3 Antibiotics resistance of Gram Positive Cocci.

Antibiotics	*S. aureus (n=92) n (%)*	*MRSA (n=20) n (%)*	*CONS (n=32) n (%)*	*MRCONS (n=22) n (%)*	*Streptococcus (n=16) n (%)*
Ampicillin	86 (93.47)	20 (100)	31 (96.87)	22 (100)	11 (68.75)
Amoxicillin	78 (84.7)	20 (100)	30 (93.75)	22 (100)	6 (37.5)
Cephradine	11 (11.95)	16 (80)	6 (18.75)	18 (81.81)	0
Cefaclor	12 (13.04)	15 (75)	8 (25)	14 (63.63)	1 (6.25)
Ceftazidime	9 (9.78)	14 (70)	7 (21.87)	13 (59.09)	0
Cefixime	7 (7.60)	17 (85)	6 (18.75)	19 (86.36)	0
Cefepime	8 (8.69)	16 (80)	8 (25)	15 (68.18)	0
Cefpirome	6 (6.52)	18 (90)	9 (28.12)	16 (72.72)	0
Ciprofloxacin	56 (60.86)	20 (100)	26 (81.25)	21 (95.45)	2 (12.5)
Erythromycin	6 (6.52)	19 (95)	27 (84.37)	22 (100)	1 (6.25)
Clarithromycin	2 (2.17)	6 (30)	3 (9.37)	6 (27.27)	1 (6.25)
Gentamicin	0	2 (10)	1 (3.12)	3 (13.63)	0
Doxycycline	4 (4.34)	14 (70)	25 (78.12)	20 (90.90)	7 (43.75)
Co-trimoxazole	45 (48.91)	19 (95)	28 (87.5)	22 (100)	9 (56.25)
Amikacin	0	1 (5)	2 (6.25)	4 (18.18)	0
Vancomycin	0	0	0	2 (9.09)	0
Linezolid	0	0	1 (3.12)	6 (27.27)	0
Fusidic acid	0	0	1 (3.12)	8 (36.36)	0
Rifampicin	3 (3.26)	4 (20)	4 (12.5)	12 (54.54)	0
Chloramphenicol	0	1 (5)	2 (6.25)	4 (18.18)	1 (6.25)
Cefoxitin	0	20 (100)	0	22 (100)	0
Novobiocin	0	5 (25)	3 (9.37)	14 (63.63)	0
Aztreonem	0	8 (40)	1 (3.12)	12 (54.54)	1 (6.25)
Clindamycin	2 (2.17)	12 (60)	3 (9.37)	19 (86.36)	2 (12.5)
Cefotaxime	0	16 (80)	6 (18.75)	16 (72.72)	0
Ticarcillin	0	1 (5)	0	2 (27.27)	0
Tigecycline	0	0	0	0	0
Pipiracillin+tazobactam	0	0	0	1 (4.54)	0

CONS: Coagulase Negative *Staphylococci,* MRCONS: Methicillin Resistant Coagulase Negative *Staphylococci,* MRSA: Methicillin Resistant *Staphylococcus aureus.*

(77.06%) while 3.66% samples were poly-microbial.[15] In comparison to our study, other studies also found *S. aureus* to be the most common causative agent.[16-18] Similar to our study, Ghosh *et al.* and Zubair *et al.* also reported dominancy of gram negative bacteria over gram positive.[19,20]

In the way of cSSSIs management, one of most important hurdle is antibiotics resistance. As penicillins are prescribed from many years in our hospital settings, therefore the resistance rate towards penicillin was high in this study. Like other studies, high resistance to amoxicillin (84.7%) in *S. aureus* was observed in our study.[21] Similar to of Najora *et al.*, 48.91% of *S. aureus* were found resistant to co-trimoxazole in this study[15]. In contrast to Tiwari *et al.* study, erythromycin resistance among *S. aureus* has decreased to 6.52% in this study and prevalence of Methicillin resistant *S. aureus* (MRSA) was high at our hospital.[21]

In case of gram negative bacilli highest resistance was seen against amoxicillin (<90%). Resistance towards third generation cephalosporins- cefepime (<90%), cefotaxime (<80%) was also high. This may be because of increasing expression of extended spectrum beta-lactamases (ESBLs) among gram negative bacilli. Ciprofloxacin susceptibility was high against all gram negative bacilli except *E. coli* for which resistance was 93.33%. Najotra *et al.* has also reported higher ciprofloxacin resistance

Table 4 Antibiotics susceptibility of Gram negative isolates.

Antibiotics	E. coli (n=60)	P. aeruginosa (n=48)	Enterobacter (n=44)	P. mirabilis (n=16)	Citrobacter (n=12)	M. morganii (n=10)	K.Pneumoniae (n=8)
Ampicillin	58 (96.66)	45 (93.75)	42 (95.45)	14 (87.5)	9 (75)	8 (80)	6 (87.5)
Amoxicillin	58 (96.66)	47 (97.91)	43 (97.72)	15 (93.75)	10 (83.33)	9 (90)	7 (87.5)
Cephradine	52 (86.66)	45 (93.75)	39 (88.63)	12 (75)	8 (66.66)	5 (50)	6 (75)
Cefaclor	51 (85)	44 (91.66)	38 (86.36)	13 (81.25)	7 (58.33)	6 (60)	5 (62.5)
Ceftazidime	53 (88.33)	46 (95.83)	35 (79.54)	11 (68.75)	6 (50)	2 (20)	7 (87.5)
Cefixime	54 (90)	43 (89.58)	39 (88.63)	14 (87.5)	8 (66.66)	4 (40)	8 (100)
Cefepime	55 (91.66)	45 (93.75)	40 (90.90)	15 (93.75)	9 (75)	3 (30)	8 (100)
Cefpirome	50 (83.33)	42 (87.5)	37 (84.09)	10 (62.5)	5 (41.66)	3 (30)	6 (75)
Ciprofloxacin	56 (93.33)	10 (20.83)	8 (18.18)	2 (12.5)	4 (33.33)	3 (30)	1 (12.5)
Erythromycin	49 (81.66)	14 (29.16)	9 (20.45)	9 (56.25)	7 (58.33)	3 (30)	6 (75)
Clarithromycin	21 (35)	22 (45.83)	25 (56.81)	6 (37.5)	2 (16.66)	3 (30)	3 (37.5)
Meropenem	59 (98.33)	44 (91.66)	42 (95.45)	16 (100)	12 (100)	10 (100)	8 (100)
Gentamicin	49 (81.66)	35 (72.91)	33 (75)	15 (93.75)	11 ()	8 (80)	6 (75)
Doxycycline	34 (56.66)	36 (75)	38 (86.36)	13 (81.25)	8 (66.66)	6 (60)	4 (50)
Co-trimoxazole	49 (81.66)	41 (85.41)	40 (90.90)	14 (87.5)	7 (58.33)	8 (80)	7 (87.5)
Amikacin	48 (80)	32 (66.66)	34 (77.27)	8 (50)	6 (50)	3 (30)	2 (25)
Linezolid	18 (30)	13 (27.08)	10 (22.72)	5 (31.25)	1 (8.33)	0	2 (25)
Rifampicin	33 (55)	29 (60.41)	26 (59.09)	7 (43.75)	1 (8.33)	0	3 (37.5)
Chloramphenicol	13 (21.66)	12 (25)	9 (20.45)	2 (12.5)	0	1 (10)	3 (37.5)
Novobiocin	26 (43.33)	28 (58.33)	23 (52.27)	3 (18.75)	2 (16.66)	0	4 (50)
Aztreonem	21 (35)	18 (37.5)	23 (52.27)	4 (25)	1 (8.33)	0	3 (37.5)
Cefotaxime	49 (81.66)	43 (89.58)	39 (88.63)	10 (62.5)	8 (66.66)	4 (40)	7 (87.5)
Ticarcillin	11 (18.33)	9 (18.75)	8 (18.18)	2 (12.5)	0	0	2 (25)
Tigecycline	0	0	0	0	0	0	0
Pipiracillin+ tazobactam	1 (1.66)	3 (6.25)	4 (9.09)	0	0	0	1 (12.5)

among E.coli. Aminoglycosides also showed good susceptibility against these isolates.[15]

High resistance was observed by gram negative isolates towards beta lactam antibiotics, towards fourth- generation cephalosporins while carbapenems like meropenem were found less resistant. Among aminoglycosides, Amikacin and gentamicin showed good sensitivity. Most of isolates were found resistant to quinolones. Pipiracillin in combination with tazobactam showed least resistance. The antibiotics susceptibility results of our study were in correspondence with findings of Basu *et al.* and Taiwo *et al*.[22,23] The information of bacterial isolates causing an infection along with their antibiotics susceptibility patterns helps the physicians for appropriate selection of antibiotics treatment and make the management more fruitful.

The higher rates of resistance might be attributed to the fact that it was a tertiary care hospital where broad spectrum antibiotics are widely used that helps in the survival of pathogens and lack of definite antibiotic policy which is a matter of great concern.

Conclusion

In conclusion this study reports the commonest organism likely to be encountered in skin and soft tissue infections is *S. aureus* followed by *E.coli* and Pseudomonas spp. Aminoglycosides, ciprofloxacin and vancomycin could be used for empirical therapy to cover these organisms. However, in the view varied bacteriology and antibiogram of SSTIs definitive antibiotic therapy should be started as soon as possible based on susceptibility reports. Lastly, continued monitoring of susceptibility pattern need to be carried out so as to detect the true burden of antibiotic resistance in organisms and prevent their further emergence by judicious use of drugs.

References

1. Barie PS, Wilson SE. Impact of evolving epidemiology and treatment for Complicated Skin and Skin Structure Infections: The Surgical Perspective. *J Am Coll Surg*. 2015; **220**: 105-16.
2. Ray GT, Suaya JA, Baxter R. Microbiology of Skin and Soft Tissue Infections in the age of Community Acquired- Methicillin Resistant Staph aureus. *Diagn Microbiol Infect Dis*. 2013;**76**: 24-30.
3. Ellis Simonsen SM, van Orman ER, Hatch BE, *et al*. Cellulitis incidence in a defined population. *Epidemiol Infect*. 2006;**134**:293–9.
4. Vinh DC, Embil JM. Rapidly progressive soft tissue infections. *Lancet Infect Dis*. 2005;**5**:501–13.
5. Eron LJ, Lipsky BA, Low DE, Nathwani D, Tice AD, Volturo GA Expert panel on managing skin and soft tissue infections. Managing skin and soft tissue infections: Expert panel recommendations on key decision points. *J Antimicrob Chemother*. 2003;**52**:3–17.
6. Xiaoyan L, Yunqin C, Weiguo G, Wenwei O, Jia W, Zehuai W. Online. Epidemiology and Outcomes of Complicated Skin and Soft Tissue Infections among Inpatients in Southern China from 2008 to 2013. *PLoS One*. 2016;**11(2)**: e0149960.
7. Pinto MN, Martinez-Gonzalez J, Chakraborty I, Mascharak PK. Incorporation of a Theranostic "Two-Tone" Luminescent Silver complex into Biocompatible Agar hydrogel composite for the eradication of ESKAPE pathogens in a Skin and Soft Tissue infection model. *Inorg Chem*. 2018; **57(11)**: 6692-6701.
8. Mark HW, Corey GR, George HT, Dirk T, David F, Tanya B. CANVAS 2: The 2nd phase III, randomized, double-blind study evaluating Ceftaroline fosamil for the treatment of patients with complicated skin and skin structure infections. *J Antimicrob Chemother*. 2010;**65(4)**: 53-65.
9. Kimberly C, Claeys Evan J, Zasowski, Abdalhamid M, Lagnf, Donald PL, Susan LD, Michael JR. Novel application of published risk factors for Methicillin Resistant S. aureus inn Acute Bacterial Skin and Skin Structure Infections. *Int J Antimicrob Agents*. 2018;**51**:43-6.
10. Forbes BA, Sahm DF, Weissfeld AS. 12th ed. St. Louis, Missouri 63043, USA: Elsevier-Mosby; 2007. Bailey and Scott's Diagnostic Microbiology.
11. Collee JG, Marr W. tests for identification of bacteria. In Collee JG, Fraser AG, Marmion BP, editors. Mackie and McCartney. Practical medical microbiology. 14 th ed. New Delhi: Churchil Livingstone; 2006: 131-49.
12. Wayne, PA: Clinical Laboratory Standards Institute; 2012. Clinical Laboratory Standards Institute. Performance Standards for Antimicrobial Susceptibility Testing; Twenty Second Informational Supplement M100-S22.
13. Malhotra SK, Malhotrs S, Dhaliwal GS, Thakur A. Bacteriological Study of Pyodermas in a tertiary Care Dermatological Center. *Indian J Dermatol*. 2012;**57**: 358-61.
14. Sowmya N, Savitha S, Mallure S, Mohankrishanan K, Sumathi G and Arumugan P . A two year study of spectrum of bacterial isolates from wound infections by aerobic culture and their antibiotic pattern in a tertiary care center. *Int J Curr Microbiol App*. 2014;**3**:292-5.
15. Najotra DK, Kakru DK. Bacteriology and antibiogram of skin and soft tissue infections from a tertiary care hospital. *India J Med Spec*. 2012;**3(1)**:26-30.
16. Mantravadi HB, Chinthaparthi MR, Shravani V. Aerobic isolates in pus and their antibiotic sensitivity pattern: a study conducted in a teaching hospital in Andhra Pradesh. *Int J Med Sci Public Health*. 2015;**4(8)**:1076-80
17. Rao DVMVSVR, Basu R, Biswas DB. Aerobic bacterial profiles and antimicrobial susceptibility pattern of pus isolates in a south Indian tertiary care hospital. *IOSR J Dent Med Sci*. 2014;**13(3)**:59–62.
18. Tiwari P, Kaur S. Profle and sensitivity pattern of bacteria isolated from various cultures in a tertiary care hospital in Delhi. *Indian J Pub Health* 2010;**54(4)**:213–15.
19. Ghosh A, Karmakar PS, Pal J, Chakraborty N, Debnath NB, Mukherjee JD. Bacterial incidence and antibiotic sensitivity pattern in moderate and severe infections in hospitalized patients. *J Indian Med Assoc*. 2009;**107(1)**:21–2.
20. Zubair M, Malik A, Ahmad J. Clinico-microbiologicalstudy and antimicrobial drug resistance profle of diabeticfoot infections in

north India. *Foot (Edinb).* 2011;**21 (1)**:6–14.
21. Tiwari HK, Das AK, Sapkota D, Sivarajan K, Pahwa VK. Methicillin resistant Staphylococcus aureus: prevalence and antibiogram in a tertiary care hospital in western Nepal. *J Infect Dev Ctries.* 2009;**3(9)**:68.
22. Taiwo SS, Okesina AB, Onile BA. In vitro antimicrobial susceptibility pattern of bacterial isolates from wound infections in University of Ilorin teaching hospital. *Afr J Clin Exp Microbiol*. 2002;**3(1)**:6–10.
23. Basu S, Ramchuran Panray T, Bali Singh T, Gulati AK, Shukla VK. A prospective, descriptive study to identify the microbiological profle of chronic wounds inoutpatients. *Ostomy Wound Manage*, 2009;**55(1)**:14–20.