Microbial profile of burn wound infections and their antibiotic sensitivity patterns at burn unit of allied hospital Faisalabad

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Abstract: Microbial infection is the most common and serious complication of burn injury, which is a major cause of morbidity and mortality. The aim of this study was to determine the bacteriological profiles and the antibiotic sensitivity patterns in burn unit of Allied Hospital Faisalabad over a period of 1 year. During the study period, 393 samples were collected and cultured by conventional method. Disk diffusion method was used to determine the sensitivity/resistance pattern of the isolates. Results were analyzed using SPPS version 20. Out of 393, 332 (84.5%) cases were found to be culture positive. Microbial contamination of the burn wounds was significantly ($p<0.05$) higher in males (89.3%) as compared to females (78.1%), and in 3rd degree burns (92.2%) as compared to 2nd degree burns (80.8%). Out of 393 patients, 258 (65.6%) cases were of *Staphylococcus aurous* followed by 169 (43.0%) of *Pseudomonas* aeruginosa 79 (20.1%) of *Klebsiella pneumoniae* and 67 (17.0%) of *Escherichia coli*. Among 258 cases of *S. aurous*, 153 (59.3%) were MRSA and 105 (40.7%) were MSSA. A large proportion (92.8%) of MRSA was sensitive to techoplanin and exhibited high-level resistant (96.7%) to fusidic acid whereas, significant proportion (74.4%) of MSSA isolates showed resistant to fusidic acid. A zero resistance was noted in coagulase negative staphylococci to linezolide, vancomycin and teichoplanin.. *Pseudomonas aeruginosa* exhibited high level resistance to tobramycin (91.7%) and were mostly sensitive (93.5%) to cefipiem. *Klebsiella penumoniae* was most sensitive to meropenem (100%) and most resistant to tobramycin (63.3%). *E. coli* showed zero resistance cefipiem and a small proportion of isolates (14.9%) exhibited resistance to tobramycin. In conclusion, *S. aurous* and *P. aeruginosa* represented the most common bacterial microbes of burn wounds which exhibited variable antibiotic susceptibility pattern. This study revealed a high potential for multiple microorganism outbreaks and emergence of resistant pathogens in burn patients due to the lack of patient screening and extended empirical use of antibiotics.

Keywords: Antibiotic sensitivity, bacteremia, burn, culture medium.

INTRODUCTION

Burn wound provides a suitable site for bacterial growth and is rich source of infection than surgical wounds. The risk of infection is correlated with extent of burn and duration of stay in hospital and also related to impaired resistance due to disruption of the skin's mechanical integrity and generalized immune suppression duration of stay in hospital. Infection is a major cause of morbidity and mortality among hospitalized patients (Aggarwal *et al*., 2002). In developing countries, it has been estimated that approximately 75% of the burn mortality is related to sepsis (Khanuja *et al*., 2002). In addition, overcrowding in burn units is a major cause of cross infection which necessitates repeated sampling for appropriate change in antibiotics (Al-Marzoqi *et al*., 2016). Burn injuries are the major health hazards causing about 10% of all surgical admissions (Rooh-ul-Muqim *et al*., 2007). According to WHO, Pakistan has a highest rate of burns i.e. 1388/100,000 as compared to worldwide incidence i.e. 110/100000 per year (Othman and Kendrick, 2010). Immediately after burn injury, Gram positive (+vie) bacteria colonize the wound followed by Gram negative (-vie) bacteria after few days (Akoda, 2011). Microorganisms routinely isolated from burn wounds are *Staphylococcus (S.) aureus*; *Pseudomonas (P.) aeruginosa*, *Escherichia (E.) coli*, *Klebsiella* (*K.*) *pneumoniae*, *Bacteroides fragilis*, *Fuscobacterium* and fungi like *Aspergillus niger* and *Candida* Spp (Asaolu *et al*., 2009). Periodically culturing and surveillance of potential microorganisms and their sensitivity/resistance pattern may help the physician to institute appropriate antibacterial therapy and to avoid further complication. Although the mortality rate associated with burn injury is comparatively low, however, it is often associated with pain, prolonged hospitalization, emotional stress, permanent disfigurement, and family stress. Around 1.5 per 1000 cases of burn from general population are presented to emergency and accident department. Among them 11 % of adult and 39 % of pediatric patients are hospitalized for treatment (Cheng, Leung *et al*., 1990). In Faisalabad (Pakistan) Burn Unit of Allied Hospital is a major regional referral center for all burn injuries. It serves approximately a population of 1.5 million and receives burn patients from other regional tertiary care centers. Patients of burn injury presented to the department of accident and emergency are managed by an

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on-call general medical officer (MO) and patients that are in need of hospitalized treatment are reassessed by plastic surgeon. The aim of this study is to determine the bacteriological profiles and the antibiotic sensitivity patterns in burn unit of Allied Hospital Faisalabad over a period of 1 year.

MATERIALS AND METHODS

Study design

This cross sectional study was conducted at Burn Unit of Allied Hospital Faisalabad-Pakistan during the 12-month period from February 2017 to January 2018.

Population and data collection

The inclusion criterion was the infection diagnosis according to the Centers for Disease Control (CDC) criteria (Horan *et al*., 2008). Data were collected through a standardized sheet of patient identification. The data of each patient including age, sex, type, degree and location and extent of burn and other such parameters were recorded. In this cross-sectional study, the *S. aurous, P. aeruginosa*, *K. pneumoniae* and *E. coli* isolates were obtained from burn wounds of different sites admitted to Burn Unit of Allied Hospital Faisalabad-Pakistan. This study enrolled 393 cases having various forms of acute burn injuries. The infection variables recorded positive culture, type of germs and antibiotic treatment with presence or absence of multi-resistant bacteria.

Isolation and identification of microorganisms

The samples were collected in normal saline soaked swab using 'Z' fashion sampling technique from different wound on day of patient admission. The swabs were placed in Brain Heart Infusion broths (with and without cefoxitin) and transported to the laboratory for isolation and identification. Briefly, the broth samples were pre-incubated at 37°C for 12 hours and plated on Blood, MacConkey and *Pseudomonas* cetrimide agar plates for isolation of selective pathogens. Methicillin resistant *S. aureus* (MRSA) were isolated by concentration techniques; pre-incubated BHI-cefoxitin broth samples were directly plated on MRSA CHROMagar™ (CHROMagar, Paris, France). Catalase positive, Gram positive colonies were presumptively identified as *staphylococci*, which finally identified by tube coagulase test (Tong *et al*., 2015) as *S. aureus* and coagulase negative staphylococci (CNS). Mauve color colonies on CHROMagar were considered as MRSA. The confirmation of methicillin resistant and sensitive *S. aureus* (MSSA) was reached by cofixitin disc susceptibility method.

For *P. aeruginosa,* yellow-green or yellow brown colonies that fluoresce under blue or UV light were presumed. The confirmation was made by Gram staining, positive oxidase and citrate tests. Growth on MacConkey agar was speciated as *E. coli* and *K. pneumoniae* by analytical profile index 20E (bioMérieux, France).

Antimicrobial susceptibility testing

Antimicrobial susceptibility pattern for each isolates were determined by disk diffusion method (Kirby-Bauer technique) on Muller Hinton agar (Oxoid) for pathogen specific antimicrobials including aztreonem, amoxacillin-clavulanic acid, ceftazidime, cefipiem, dorepenem, fusidic acid, imipenem, linzolide, lincomycin, meropenem, moxifloxacin, piperacillin-tazobactam, teichoplanin, tobramycin and vancomycin).

STATISTICAL ANALYSIS

Statistical analyses were performed using the Statistical Package for the Social Science (SPSS), Version 20 for windows. Continuous variables were summarized using descriptive statistics in terms of Chi square (χ^2) test, 95% confidence intervals (95% CI), and p value<0.05 was considered as significant.

RESULTS

Out of 393, 332 (84.5%) cases were found to be culture positive. Bacterial isolation rate was significantly higher (0.002) in samples from males (89.3%) as compared to female (78.1%) patients. The patients above 70 years of age were 100% culture positive. The isolation rate was significantly higher (p=0.002) in 3rd degree burn (92.2%) as compared to 2nd degree (80.8%). Rate of isolation was higher (86.2%) in samples taken from extremities as compared to other anatomical locations. Nonetheless, this difference was non-significant statistically (p=0.741). Bacterial culture was more positive in unspecified burns (93.3%) as compared to other causes (p =0.496). Bacterial isolation rate was higher in patients with 30.1 to 50% total body surface area (TBSA; 91.4%) of burn as compared to other categories, however, this differed insignificantly (p=0.514). Positivity of a samples being positive was higher in died patients (89.5%) as compared to referred (86.7%) and discharged patients (83.2%), p=0.442 (table 1).

Staphylococcus aureus and coagulase negative Staphylococci

Three categories of staphylococci viz., methicillin resistant, methicillin sensitive *S. aureus* (MRSA and MSSA) and coagulase negative staph (CNS) were identified in wound swab cultures.

Over all prevalence of MRSA, MSSA and CNS was 38.9, 26.7 and 9.1 percent. Rate of isolation of MRSA and MSSA was significantly higher in males as compared to females (table-2).,MRSA culture was more positive in patients above 70 years of age (50%) as compared to other groups, where, the corresponding group for MSSA was 15.1-30 years of age. Prevalence of MRSA and MSSA was numerically higher in patients with 3rddegree burn (39.8 and 30.4 percent) as compared to 2nd degree burn (38.5 and 26.0 percent). However, the prevalence estimates were statistically insignificant. Isolation of both MRSA and MSSA was higher in samples collected from extremities in comparison to other anatomical locations. Similarly, electric burn wounds yielded more MRSA (54%) and MSSA (40%) than other burn types (table-2). This difference was statistically significant (p=0.015) for MRSA Approximately 43% MRSA were found in patients with 50.1-70% TBSA in comparison to other categories. For MSSA, maximum isolation (35.7%) was recorded in15% TBSA. Isolation rate of MRSA was higher in referred followed by died and discharged patients, whereas, MSSA was more prevalent in patients that succumb to burns.

The antibiotic susceptibility and resistance profile (fig. 1 & 2) indicated that MRSA was most sensitive to techoplanin (92.8%) and was less sensitive to lincomycin (3.9%), imipenem (3.3%) and fusidic acid (3.3%). MRSA was less resistant to teichoplanin (7.2%), vancomycin (7.9%) and linzolide (8.5%) and was more resistant to fusidic acid (96.7%), lincomycin (96.1%), imipenem (96.7%) and amoxicillin-Clavulanic acid (91.5%).

The antibiotic susceptibility and resistance profile (fig. 1 & 2) indicated that MSSA was most sensitive to vancomycin (100%) and less sensitive to imipenem (20.9%). MSSA was slightly resistant to linezolide (2.9%) and teichoplanin (3.8%) and was more resistant to fusidic acid (74.3), lincomycin (70.5%), imipenem (79.1%) and amoxicillin-clavulanic acid (78.1%). None of the MSSA isolates showed resistance to vancomycin.

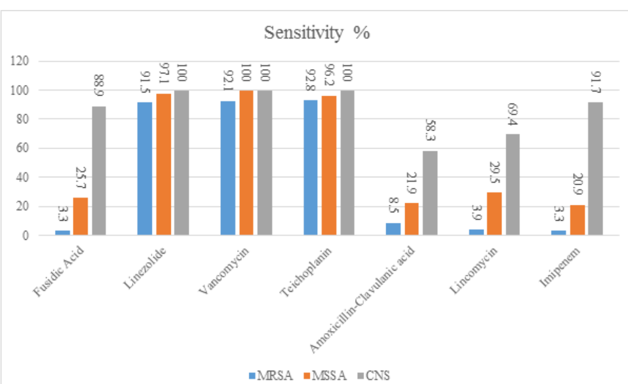

Fig. 1: Sensitivity (%) of the MRSA, MSSA and CNS against different antibiotics.

***Coagulase negative staphylococci* (CNS)**
Antimicrobial susceptibility pattern of CNS revealed low level resistance to imipenem (8.3%), followed by fusidic acid (11.1%) and lincomycin (30.6%). However, a significant proportion (41.7%) of CNS was resistant to amoxicillin-clavulanic acid. A zero resistance was registered to linezolide, vancomycin and teichoplanin.

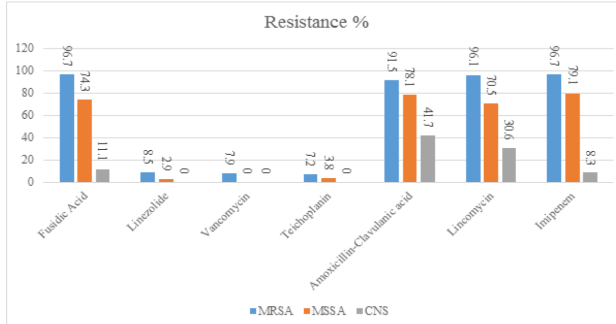

Fig. 2: Resistance (%) of the MRSA, MSSA and CNS against different antibiotics

Pseudomonas aeruginosa
The prevalence of *P. aeruginosa* was 43% and rate was higher in males (47.3%) than females (37.3%) which differed significantly (p=0.046). *Pseudomonas* culture was positive in 15.1-30 years of age patients (52.1%) with p value 0.506. *Pseudomonas* culture was more positive in patients with third degree burn (44.5%) as compared to 2nd degree burn (42.3) with p value 0.671. *Pseudomonas* culture was more positive in head and neck (47.3%) with p value 0.573. *Pseudomonas* culture was more positive in chemical burns (53.1%) with p value 0.732. *Pseudomonas* culture was more positive in less than 15% extent of burn (46.4%) with p value 0.649. *Pseudomonas* culture was more positive in discharged patients (43.6%) as compared to referred (40%) and died patients (42.1%) with p value 0.890 (table 2).

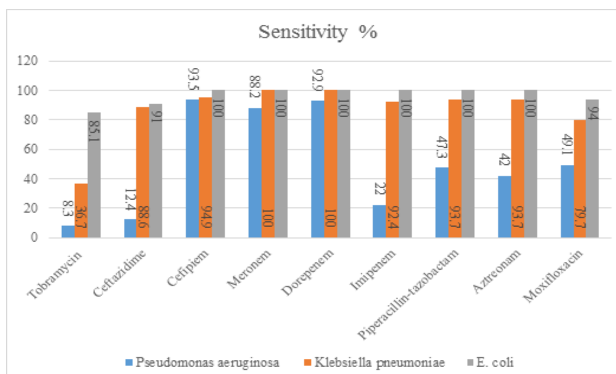

Fig. 3: Sensitivity (%) of the *Pseudomonas aeruginosa*, *K. penumoniae* and *E. coli* against different antibiotics.

The antibiotic susceptibility and resistance profile (figs. 3 & 4) indicated *Pseudomonas aeruginosa* was most sensitive to cefipiem (93.5%), dorepenem (92.9%) and meropenum (88.2%) and was less sensitive to tobramycin (8.28%). *Pseudomonas* was most resistance to tobramycin (91.7%) and least resistant to cefipiem (6.5%).

Klebsiella pneumoniae
K. pneumoniae culture was more positive in female (23.7%) as compared to male (17.4%) with p value 0.125. *K. pneumoniae* culture was positive in 4.1-15 years of age

patients (23.3%) with p value 0.877. *K. pneumoniae* culture was more positive in patients with third degree burn (22.7%) as compared to 2nd degree burn (18.9%) with p value 0.380. *K. pneumoniae* culture was more positive in upper part of body (27.9%) with p value 0.487. *K. pneumoniae* culture was more positive in unspecified burns (40%) with p value 0.091. *K. pneumoniae* culture was more positive in 50.1-70% and above 70% extent of burn (21.4%). *K. pneumoniae* culture was more positive in referred patients (28.9%) as compared to discharged (18.2) and died patients (22.8%) with p value 0.216 (table 2).

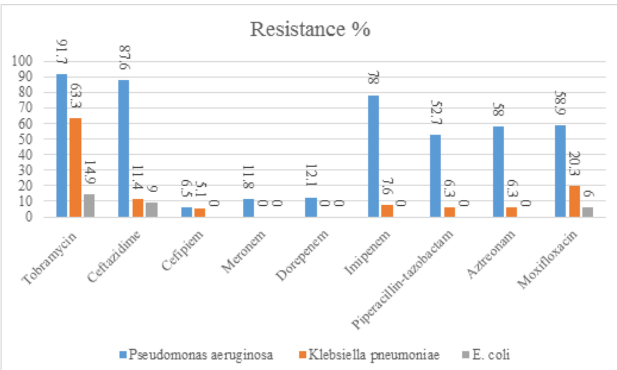

Fig. 4: Resistance (%) of the *Pseudomonas aeruginosa*, *K. penumoniae* and *E. coli* against different antibiotics

The antibiotic susceptibility and resistance profile (fig. 3 & 4) indicated *K. penumoniae* was most sensitive to Meropenem (100%) and dorepenem (100%) and was less sensitive to tobramycin (36.7%). *K. pneumoniae* is most resistant to tobramycin (63.3%) and least resistant to cefipiem (5.1%).

Escherichia coli (E. coli)

E. coli culture was more positive in female (21.3%) as compared to male (13.8%) with p value 0.051. *E. coli* culture was positive in 4.1-15 years of age patients (18.5%) with p value 0.981. E. coli culture was more positive in patients with third degree burn (34.4%) as compared to 2nd degree burn (8.7%) with p value 0.001. *E. coli* culture was more positive in head and neck (20.5%) with p value 0.514. *E. coli* culture was more positive in accidental burns (35.7) with p value 0.498. *E. coli* culture was more positive in more than 50.1-70% extent of burn (45.2%) with p value 0.001. *E. coli* culture was more positive in died patients (43.9%) as compared to discharged (11.7%) and referred patients (17.8%) with p value 0.001 (table 2).

None of the isolates exhibited zero resistance to cefipiem, meropenem dorepenem, imipenum, piperacillin-tazobactam, and aztreonem. A slight resistance was noted to tobramycin (14.9%) followed by ceftazidime (9%), moxifloxacin (6%) and imipenem (2%).

DISCUSSION

Burn is one of the most common and devastating forms of trauma (Kuang, Li *et al*., 2018). Patients with severe burn injury require immediate specialized care in order to minimize morbidity and mortality (Benariba, Djaziri *et al*., 2013). In the past few decades, although survival rates of burn have improved substantially due to advances in modern medical care in specialized burn centers. However nosocomial infections represent a major challenge for a burn team in burn patients, which are a major cause (over 50%) of burn deaths. In the world, burn is considered one of the major health problems. S. aureus was the most commonly recognized microbe in burn patients in agreement to our study, some previous studies show that most common microbe of burn wound was *S. aureus* (Clark, 1996, Conforti, Statti *et al*., 2007). Our study is also similar to another study conducted in burn unit in Shafiq Aziz Burn Hospital, Lahore, Pakistan that showed *S. aureus* was most abundant strains (Swallow, 2003). In contrast to other study conducted at Burn Care Centre, Pakistan Institute of Medical Sciences (PIMS), Islamabad showed that most frequent isolates found was *Pseudomonas aeruginosa* (Solomons, 2003). In another study showed that *S. aureus* is the most common isolate (Abdel-Wahhab and Ahmed, 2004). The 2nd most common organism in burn patients was *P. aeruginosa*. Our findings differs from previous studies in which *P. aeruginosa* was most common organism found in burn patients (Buleandra *et al*., 2016, Chong-Zhi *et al*., 2016). *P. aeruginosa* is suggested to be the 2nd most important cause of infection among burn patients as it has the capacity to grow on moist surfaces, particularly burn wounds, which is the ultimate setting for infectivity and colonization of this *P. aeruginosa*. *P. aeruginosa* was most sensitive to cefipiem and dorepenem and was less sensitive to tobramycin (DeRisi *et al*., 1997).

The 3rd most common identified microbe in our studies was *K peneumoniae*, in contrast to previous studies in which 2nd most commonest cultured organism was *K. peneumoniae* (Cui *et al*., 2014). However, in other studies, *K. peneumoniae* was reported as the most common organism of burn infection (Cui *et al*., 2014, Dashwood, 2002).

K. pneumoniae was most sensitive to meropenem and dorepenem and was less sensitive to tobramycin. E. coli was most sensitive to cefipenem, meropenem, dorepenem, imipenum, piperacillin-tazobactam, aztreonem and was less sensitive to tobramycin. *K. pneuumoniae* and *E. coli* is sensitive to imipenem, ceftazidime and tobramycin. *E. coli*, *K. pneumoniae* and *P. aeruginosa* is sensitive to dorepenem, cefipiem, meropenem, piperracillin tazobactam, aztreonem and moxifloxacin. Pseudomonas was most resistance to tobramycin and least resistant to cefipiem. *K. pneumoniae* is most resistant to tobramycin

Table 1: Number and percentage of the different variables with reference to the bacterial culture of burn cases in the patients presented at burn unit of allied hospital, Faisalabad, Pakistan

Variable	Category	Culture Positive		
		Pos./Tested	Positive % (95% CI)	p Value
Gender	Female	132/169	78.1 (71.1-84.1)	χ^2 = 9.181 p = 0.002
	Male	200/224	89.3 (84.5-93)	
Age Group	Up to 4 Years	83/103	80.6 (71.6-87.7)	χ^2 = 3.635 p = 0.458
	4.1 to 15 Years	88/103	85.4 (77.1-91.6)	
	15.1 to 30 Years	62/69	89.7 (80.2-95.8)	
	30.1 to 69 Years	95/114	83.3 (75.2-89.7)	
	Above 70 Years	4/4	100 (39.8-100)	
Degree of Burn	2nd degree	214/265	80.8 (75.5-85.3)	χ^2 = 8.604 p = 0.003
	3rd Degree	118/128	92.2 (86.1-96.2)	
Anatomical Location	Extremities	112/130	86.2 (79-91.6)	χ^2 = 1.252 p = 0.741
	Head and Neck	95/112	84.8 (76.8-90.9)	
	Lower part of body	91/108	84.3 (76-90.6)	
	Upper Part of Body	34/43	79.1 (64-90)	
Cause of Burn	Accidental Burn	11/14	78.6 (49.2-95.3)	χ^2 = 6.381 p = 0.496
	Acid Burn	20/23	86.9 (66.4-97.2)	
	Chemical Burn	29/32	90.6 (75-98)	
	Electric Burn	46/50	92 (80.8-97.8)	
	Flame Burn	113/140	80.7 (73.2-86.9)	
	Radiation Burn	14/16	87.5 (61.7-98.4)	
	Scald Burn	85/103	82.5 (73.8-89.3)	
	Unspecified	14/15	93.3 (68.1-99.8)	
Extent of Burn	<= 15.0%	23/28	82.1 (63.1-93.9)	χ^2 = 3.266 p = 0.514
	15.1-30.0%	228/274	83.2 (78.2-87.4)	
	30.1-50.0	32/35	91.4 (46.9-98.2)	
	50.1-70.0%	38/42	90.5 (77.4-97.3)	
	> 70.0%	11/14	78.6 (49.2-95.3)	
Outcome	Discharged	242/291	83.2 (78.4-87.3)	χ^2 = 1.634 p = 0.442
	Referred	39/45	86.7 (73.2-94.9)	
	Died	51/57	89.5 (78.5-96)	

and least resistant to cefipiem. No resistance occurred by used of meropenem and durepenem. *E. coli* showed resistance by use of tobramycin and no resistance was seen in case of other antibiotics. Resistance (%) of the *P. aeruginosa* and *E. coli* against tobramycin is 91.7% and 14.9% respectively. In the case of pseudomonal infections, most common prescribed antibiotic is ceftazidime, however in current study resistance of the *P. aeruginosa* against ceftazidime is 37.6%. With this proof base in mind, we can revise our guidelines of empiric antibiotic therapy for our burn patients with sepsis.

In our study, *pseudomonas* was most sensitive to cefipeim, meropenem and dorepenem (fig. 3) and least resistant to cefipeim, meropenem and dorepenem (fig. 4). MRSA and MSSA was most sensitive to linzolide, vancomycin and teichoplanin

In our study, resistance of the *P. aeruginosa* against imipenem, moxifloxacin, azotreonem and piperacillin-tazobactum is 78%, 58.9%, 58% and 52.7% respectively. This study is in accordance with previous study in which *P. aeruginosa* was found resistant to 10 antibiotic spectrums (glycylcyline and quinolones, cephalosporin, tetracycline, aminoglycosides, chloramphenicol, sulfonamide, carbapenem, monobactam and penicillin + beta lactamase inhibitors (De Fátima Navarro, De Souza *et al*., 2002).

In this study MRSA instituted an alarmingly high percentage (n=153/258=59.30%) of the staphylococcal isolates. As the reservoirs of MRSA are not only present in hospital but also large reservoirs also exist outside the healthcare facilities. Patients of burn injury are susceptible to both health care-associated MRSA (HA-MRSA) infections as well as the community associated

MRSA (CA-MRSA). Infection of MRSA usually follows carriage of microorganism for some period. In the epidemiology of MRSA "5 Cs": contact with infected cases, Contaminated fomites, Compromised skin, Cleanliness and Crowded living together with prior antibiotic are all important. Adaptation of standard universal rules of contact precautions,

Table 2: Number and percentage of the different microorganism isolated from the burn wounds of patients presented at Allied Hospital, Faisalabad, Pakistan with reference to various variables.

Variable	Category	MRSA		MSSA		*Pseudomonas*		*Klebseilla*		*E coli*	
		Pos./ Tested	Pos. % (95% CI)	Pos./ Tested	Pos. % (95% CI)	Pos./ Tested	Pos. % (95% CI)	Pos./ Tested	Pos. % (95% CI)	Pos./ Tested	Pos. % (95% CI)
Gender	Female	51/169	30.2 (23.4-37.7)	37/169	21.9 (15.9-28.9)	63/169	37.3 (30-45)	40/169	23.7 (17.5-30.8)	36/169	21.3 (15.4-28.3)
	Male	102/224	45.5 (38.9-52.3)*	68/224	30.4 (24.4-36.8)	106/224	47.3 (40.6-54.1)*	39/224	17.4 (12.7-23)	31/224	13.8 (9.6-19.1)
Age Group	Up to 4 Years	37/103	35.9 (26.7-46)	28/103	27.2 (18.9-36.8)	42/103	40.8 (31.2-50.9)	18/103	17.5 (10.7-26.2)	17/103	16.5 (9.9-25.1)
	4.1 to 15 Years	31/103	30.1 (21.5-39.9)	26/103	25.2 (17.2-34.8)	43/103	41.8 (32.1-51.9)	24/103	23.3 (15.5-32.7)	19/103	18.5 (11.5-27.3)
	15.1 to 30 Years	33/69	47.8 (35.6-60.2)	21/69	30.4 (19.9-42.7)	36/69	52.1 (39.8-64.4)	14/69	20.3 (11.6-31.7)	11/69	15.9 (8.2-26.7)
	30.1 to 69 Years	50/114	43.9 (34.6-53.5)	29/114	25.4 (17.7-34.4)	47/114	41.2 (32.1-50.8)	22/114	19.3 (12.5-23.7)	19/114	16.7 (10.3-24.8)
	Above 70 Years	2/4	50 (6.8-93.2)	1/4	25 (0.6-80.6)	1/4	25 (0.6-80.6)	1/4	25 (0.6-80.6)	1/4	25 (0.6-80.6)
Degree of Burn	2nd degree	102/265	38.5 (32.6-44.6)	69/265	26 (20.9-31.8)	112/265	42.3 (36.2-48.5)	50/265	18.9 (14.3-24.1)	23/265	8.7 (5.6-12.7)
	3rd Degree	51/128	39.8 (31.3-48.9)	36/128	28.1 (20.5-36.8)	57/128	44.5 (35.7-53.6)	29/128	22.7 (15.7-30.9)	44/128	34.4 (26.2-43.3)*
Anatomical Location	Extermities	60/130	46.2 (37.4-55.1)	40/130	30.8 (23-39.5)	56/130	43.1 (34.4-52)	26/130	20 (13.5-27.9)	23/130	17.7 (11.6-25.4)
	Head and Neck	38/112	33.9 (25.3-43.5)	30/112	26.8 (18.9-36)	53/112	47.3 (37.8-57)	23/112	20.5 (13.5-29.2)	23/112	20.5 (13.5-29.2)
	Lower part of body	36/108	33.3 (24.6-43.1)	25/108	23.2 (15.6-32.2)	41/108	37.9 (28.8-47.8)	18/108	16.7 (10.2-25.1)	14/108	12.9 (7.3-20.8)
	Upper Part of Body	19/43	44.2 (29.1-60.1)	10/43	23.3 (11.8-38.6)	19/43	44.2 (29.1-60.1)	12/43	27.9 (15.3-43.7)	7/43	16.3 (6.8-30.7)
Cause of Burn	Accidental Burn	6/14	42.9 (17.7-71.1)	3/14	21.4 (4.7-50.8)	6/14	42.9 (17.7-71.1)	2/14	14.3 (1.8-42.8)	5/14	35.7 (12.8-64.9)
	Acid Burn	6/23	26.1 (10.2-48.4)	8/23	34.8 (16.4-57.3)	9/23	39.1 (19.7-61.5)	4/23	17.4 (5-38.8)	2/23	8.7 (1.1-28)
	Chemical Burn	12/32	37.5 (21.1-56.3)	5/32	15.6 (5.3-32.8)	17/32	53.1 (34.7-70.9)	6/32	18.8 (7.2-36.4)	5/32	15.6 (5.3-32.8)
	Electric Burn	27/50	54 (39.3-68.2)*	20/50	40 (26.4-54.8)	19/50	38 (24.7-52.8)	15/50	30 (17.9-44.6)	8/50	16 (7.2-29.1)
	Flame Burn	61/140	43.6 (35.2-52.2)	37/140	26.4 (19.3-34.5)	63/140	45 (36.6-53.6)	24/140	17.1 (11.3-24.4)	28/140	20 (13.7-27.6)
	Radiation Burn	7/16	43.8 (19.8-70.1)	6/16	37.5 (15.2-64.6)	4/16	25 (7.3-52.4)	6/16	37.5 (15.2-64.6)	2/16	12.5 (1.6-38.3)
	Scald Burn	26/103	25.2 (17.2-34.8)	24/103	23.3 (15.5-32.7)	45/103	43.7 (33.9-53.8)	16/103	15.5 (9.1-24)	15/103	14.6 (8.4-22.9)
	Unspecified	8/15	53.3 (26.6-78.7)	2/15	13.3 (1.7-40.5)	6/15	40 (16.3-67.7)	6/15	40 (16.3-67.7)	2/15	13.3 (1.7-40.5)
Extent of Burn	<= 15.0%	10/28	35.7 (18.6-55.9)	10/28	35.7 (18.6-55.9)	13/28	46.4 (27.5-66.1)	4/28	14.3 (4-32.7)	1/28	3.6 (0.1-18.3)
	15.1-30.0%	108/274	39.4 (33.6-45.5)	69/274	25.2 (20.2-30.8)	114/274	41.6 (35.7-47.7)	58/274	21.2 (16.5-26.5)	29/274	10.6 (7.2-14.8)
	30.1-50.0	13/35	37.1 (21.5-55.1)	11/35	31.4 (16.9-49.3)	19/35	54.3 (36.6-71.2)	5/35	14.3 (4.8-30.3)	12/35	34.3 (19.1-52.2)
	50.1-70.0%	18/42	42.9 (27.7-59)	13/42	30.9 (17.6-47.1)	18/42	42.9 (27.7-59)	9/42	21.4 (10.3-36.8)	19/42	45.2 (29.8-61.3)*
	> 70.0%	4/14	28.6 (8.4-58.1)	2/14	14.3 (1.8-42.8)	5/14	35.7 (12.8-64.9)	3/14	21.4 (4.7-50.8)	6/14	42.9 (17.7-71.1)
Outcome	Discharged	109/291	37.5 (31.9-43.3)	76/291	26.1 (21.2-31.6)	127/291	43.6 (37.9-49.6)	53/291	18.2 (14-23.1)	34/291	11.7 (8.2-15.9)
	Referred	21/45	46.7 (31.7-62.1)	11/45	24.4 (12.9-39.5)	18/45	40 (25.7-55.7)	13/45	28.9 (16.4-44.3)	8/45	17.8 (8-32.1)
	Died	23/57	40.4 (27.6-54.2)	18/57	31.6 (19.9-45.2)	24/57	42.1 (29.1-55.9)	13/57	22.8 (12.7-35.8)	25/57	43.9 (30.7-57.6)

*values are significantly different from other related categories, $p<0.05$

hand hygiene and barrier nursing by all hospital personnel can effectively prevent the cross infection among hospitalized patients (David and Daum, 2010)

In this study, MRSA was most sensitive to linezolide and was less sensitive to lincomycin, imipenem and fusidic acid. MSSA was most sensitive to vancomycin and less sensitive to imipenem. CNS was most sensitive against linezolide, vancomycin and teichoplanin and was less sensitive against amoxicillin-clavulanic acid. Sensitivity (%) of the MRSA, MSSA and CNS against vancomycin is 92.1, 100 and 100 respectively. Sensitivity of the MRSA, MSSA and CNS against linzolide is 91.5%, 97.1% and 100% respectively. Sensitivity (%) of the MSSA and CNS against fusidic acid is 25.7 and 88.9 respectively. Sensitivity (%) of the MSSA and CNS against imipenem is 20.9, 91.7 respectively. Sensitivity (%) of the MSSA and CNS against lincomycin is 29.5 and 69.4 respectively. Sensitivity (%) of the MSSA and CNS against Amoxacillin-clavulanic acid is 21.9% and 58.3% respectively. linzolide and vancomycin has shown the higher sensitivity pattern demonstrated by MRSA, MSSA and CNS as compared to other antibiotics such as lincomycin, imipenem, fusidic acid, imipenem, amoxicillin-clavulanic acid.

MRSA was less resistant to linezolide, vancomycin and teichoplanin and was more resistant to Fusidic acid, lincomycin, imipenem and amoxicillin-clavulanic acid. MSSA was slightly resistant to Linezolide and teichoplanin and was more resistant to Fusidic acid, lincomycin, imipenem and amoxicillin-clavulanic acid. MSSA showed no resistance to vancomycin. CNS shoed no resistance to linezolide, vancomycin and teichoplanin and was more resistant to Fusidic acid, lincomycin, imipenem and amoxicillin-clavulanic acid.

Resistance (%) of the MRSA, MSSA and CNS against fusidic acid is 96.7, 74.3 and 11.1 respectively. Resistance (%) of the MRSA, MSSA and CNS against linzolide is 8.5, 2.9 and 0.00 respectively. Resistance (%) of the MRSA, MSSA and CNS against vancomycin is 7.9, 0.00 and 0.00 respectively. Resistance (%) of the MRSA, MSSA and CNS against teichoplanin is 7.2, 3.8 and 0 respectively. Resistance (%) of the MRSA, MSSA and CNS against amoxacillin-clavulanic acid is 91.5, 78.1 and 41.7 respectively. Resistance (%) of the MSSA and CNS against lincomycin is 96.1, 70.5 and 30.6% respectively. Resistance (%) of the MSSA and CNS against imipenem is 96.7, 79.1 and 8.3% respectively.
Teichoplanin was the most potent (92.8%) antimicrobial agents against MRSA followed by vancomycin (92.1%) whereas vancomycin was most effective against MSSA followed by linezolid (2.9%). And in case of CNS, linzolide, vancomycin and teichoplanin, all are effective (100%) followed by imipenem (8.3%).

It was revealed that MRSA showed equal resistance (96.7%) to each fusidic acid and Imipenem followed by lincomycin (96.1%), amoxicillin-clavulanic acid (91.5%), linezolide (8.5%), vancomycin (7.9%) and teichoplanin (7.2%).

Considering the high resistance rate in our study, it may be assumed that the unsuccessful treatment of burn patients is a consequence of high mortality. Antibiotic resistance in burn patients prolongs illness and increases health care cost hence complicates the treatment which ultimately happens a serious life-threatening condition for the patient (Dhingra *et al*., 2004). This is particularly important in Pakistan where antibiotics are prescribed without laboratory guidance as well as over the counter sales of antibiotics is common practices. This study revealed a high potential for multiple microorganisms outbreaks and emergence of resistant pathogens in burn patient's due to lack of patients screening and extended empirical use of antibiotics. This indicates the necessity to implement a system of antibiotic stewardship and infection prevention where microbiological diagnostics results are made available to physician for better management of burn patients.

CONCLUSION

Current research will be supportive in providing useful strategy for selecting successful empirical therapy which will have enormous impact on reducing mortality and morbidity of burn patients due to septicemia/bacteremia. We also suggest that prevalent micro flora, their resistance and sensitivity pattern should be studied for prevention of the emergent multi drug resistant strains, due to of haphazard utilization of antibiotics. Treatment of MRSA infection requires prompt source control and initiation of active antimicrobial therapy. Vancomycin and teichoplanain remains the initial antibiotic of choice for the treatment of MRSA infection as it shows almost similar results.

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