SMGroup

Annals of Burns and Trauma

Research Article

Pattern of the Burn Wounds Infections in Bahrain Defence Force Military Hospital

Mohammad Abdulaziz Dahag, Nayef A Louri*, Nigamananda Dey and Siji Susan Philip

Department of Plastic, Reconstructive Surgery and Burn Unit, Bahrain Defence Force Royal Medical Services Military Hospital, Bahrain

Article Information

Received date: Jul 09, 2018
Accepted date: Jul 20, 2018
Published date: Jul 25, 2018

***Corresponding author**

Nayef A Louri, Department of Plastic, Reconstructive Surgery and Burn Unit, Bahrain Defence Force Military hospital, Riffa, Southern Governorate, Bahrain, Tel: +973 1776 7950;
Email: bdfburn@gmail.com

Keywords Burn Wound; Wound Infections; Nosocomial Infections; Incidence; Bahrain

Abstract

Background: Loss of skin as the first line of defence suppress immune system, extend hospital stay and makes burn patients more vulnerable to acquire healthcare associated infections. Such infections become the reason for mortality and morbidity in burn patients. Therefore, continuous monitoring of the pattern of nosocomial infection and drug resistance is necessary for assuring patient safety and healthcare quality improvement.

Aim: To describe the microbial profile of infections among burn patients admitted to Bahrain Defence Force Military Hospital.

Method: This is a retrospective cohort study involving 295burn patients. Wound swab method was used to isolate the microorganisms first on admission and then on suspicion of infection. The overall percentage of wound culture positive cases was 11.8% and the wound infection percentage was 5% of the total number of patients admitted to the unitA total of 126 swabs was performed from the burn wounds.

Results: Gram+ bacteria S.aureus was predominant in initial cultures. It was however, succeeded by Gram- bacteria, Pseudomonas, from third culture onwards. Fungal infection with Candida was most prevalent (n=21, 16.7%). With TBSA >30% polymicrobial growth was observed which tend to increase with increase length of hospitalization. A greater proportion of patients (42.9%, n=15) had acquired healthcare associated infections and was negatively associated with increased length of hospitalization(r=-0.418, p=0.012).

Conclusion: 5% of the total patient population was categorized as health care associated infection cases. Gram negative bacteria, Pseudomonas were the prevalent microorganism isolated from wound infection of the burn patients.

Introduction

Till date, development of early bacterial infection remains one of the major challenges of patient safety in managing burn patients. Despite numerous advancements made in the antimicrobial medications, infection still accounts for approximately 75% of all the deaths in burn injuries among patients globally [1]. Burn destroys the first line of defense against microbes, the skin, and suppresses the immune system. Further, avascularized necrotic tissue in the burn area provides an excellent growth medium to the microbes. Together, these conditions make burn wound more prone to acquire infections and development of sepsis [2].

In the beginning, thermal injuries are supposed to be free of any infections. However, within 48 hrs, the endogenous microbial flora of the patients, which are mostly Gram positive bacteria, colonizes the wound followed by colonization with Gram negative bacteria from patient's gastrointestinal and respiratory tract as well as hospital environment (i.e. of nosocomial origin). The spectrum of these microbial floras is dependent on individual hospital and varies with time as well as the prolonged length of hospital stay [3]. Moreover, prolonged use of antibiotics such as third generation cephalosporins, leads to selection of Multi Drug Resistant Strain (MDRS) of microbes [4-6]. Burn injuries when infected with MDRS become difficult to treat as less antimicrobial effective against them are available, thus resulting in prolonged hospital stay and greater mortality rate [7]. Therefore, periodic reviews of the bacterial flora of burn wounds should be carried out to know the pattern of predominant organisms and the treatment of the patients before getting the result of microbiological cultures in such a manner that the development of antibiotic resistance can be avoided against MDRS as well as effectively controlling infection in patients. This would be crucial to reduce the overall infection-related morbidity and mortality [8].

The aim of the present study is to estimate the incidence of burn wounds infections and describe the epidemiology profile of microbial flora among the burn patients in Bahrain Defense Force Military Hospital.

Materials and Methods

Study setting and population

This is a retrospective cohort study conducted in the burn unit of military hospital, Bahrain from February 2015 till April 2017. During this period, a total of 295 patients having acute burn injuries due to various reasons were admitted into the hospital burn unit.

Exclusion criteria includes

Pregnant women, diabetic patients, patients with immunosuppressive diseases or receiving any immunosuppressive therapy and patients who followed the open dressing method or underwent surgical coverage procedure as split thickness skin graft in the first 24 days post burn.

Sample collection procedures

All the samples were collected under complete aseptic conditions. Wound swabs were used to collect the infection data after thorough cleaning of the wound with sterile saline. A sterile cotton swab is moistened with sterile normal saline and rubbed onto the burn wound surface. Swabs are taken from deep areas, areas with discharge or thick eschar. The swabs were transported within 1 hr of collection to the Microbiology laboratory for bacteriological isolation and identification. Swabs for anaerobic culture were transported in thioglycolate broth in well-sealed bottles. Afterwards, the samples were plated on culture media as soon as possible. MacConkey agar, nutrient agar and blood agar media were used and were incubated at 37°C for 24 hours after inoculation. Samples from the burn wound were collected from patients when clinical signs of local infection was suspected or appeared and before skin grafting.

Sample processing

Discs with 30 mkg cefoxitin (Becton Dickinson) were used to distinguish between Methicillin-Resistant Staphylococci (MRS) and Methicillin-Susceptible Staphylococci (MSS). Those isolates that showed zone of inhibition <21 mm were considered as MRSA. In addition, oxacillin screen agar (bioMerieux) was utilized for detection of metyhicillin-resistant *S. aureus* (MRSA). *S. aureus* ATCC 25923 was included as a reference strain for quality control. The initial screening for ESBL production was carried out according to CLSI guidelines.

Fungal cultures were obtained on Sabouraud dextrose agar (Difco) and on "mycogel" agar (Oxoid) at 37°C and observed daily for 20 days. The characterization of fungi was done by the germ tube test, morphological examination and automated method Vitek YBC yeast identification system (bioMérieuxVitek, Inc., MI, US).

Sample quality control

All the samples were processed in triplicate to ensure reliability. Enterococcus faecalis (ATCC 29212), *Staphylococcus aureus* (ATCC 24923), *Streptococcus pyogenes* (ATCC 19615), *E. coli* (ATCC 25922), *Pseudomonas aeruginosa* (ATCC 27853) were used as quality control throughout the study for culture, Gram stain. All the strains were obtained from the ATCC, (The essential of live science research, USA).

Statistical analysis

All the data were entered and analyzed using Statistical Software for Social Sciences (SPSS) version 21. Frequency and percentage or Mean±standard deviations were used to describe the data. Comparisons between different groups were performed using Chi-squared test and Fischer's exact test. Bivariate correlation (Pearson's coefficient) was used to explore any significant association between study variables, and p value ≤0.05 was considered statistically significant.

Results

From February 2015 till April 2017, a total of 295 patients were admitted to the Burn unit of our hospital of which 35 cases (11.8%) were swab culture positive and were included in this study. Out of 35 cases, 15 cases (5.08% of total patients) were considered as healthcare associated infection according to our hospital policy. The mean age of the patients included was 26±19.54 years (Range 2-79 years). Incidence of burn was more frequent in male (62.9%, n=22) than females (37.1% n=13). The Total Body Surface Area (TBSA) range from 1% -70%, 11-20% included highest number of patients (28.6%).

Table 1: Characteristics of patients included in the study.

Patient details	% (n)
Total no. of admissions	295
Swab culture positive case	35 (11.8%)
Total no. of infected case	15 (5.08%)
Mean age, (Range)	26±19.54 years (2-79 years)
Gender	
Male	62.9% (n=22)
Female	37.1% (n=13)
TBSA	
1-10%	25% (n=8)
11-20%	28.1% (n-9)
21-30%	15.6% (n=5)
31-40%	21.9% (n=7)
>40%	9.4% (n=3)
Degree of burn	
1st	8.6% (n=3)
2nd	74.3% (n=26)
3rd	17.1% (n=6)
Burn cause	
Flame	31.4% (n=11)
Thermal	28.6% (n=10)
Scald	28.6% (n=10)
Electric	5.7% (n=2)
Others	5.7% (n=2)
Prevalent burn cause in different age groups	
<15 years	Scald (46.2%, n=6)
>15 years	Flame (40.9%, n=9)

Table 2: Details of wound swabs.

Total no. of wound swabs	**126**
Culture positive	109 (86.5%)
Culture negative	17 (13.5%)
Monomicrobial growth	58 (46%)
Polymicrobial growth	51 (40.5%)

Table 3: Prevalence of microbial isolates with types of infection.

Polymicrobial	No.	%	Monomicrobial	No.	%
K.pneumonia+ *Enterococci* spp.	1	0.9	*K.pneumonia*	3	2.7
K.pneumonia+ *Pseudomonas* spp.	1	0.9	*Pseudomonas* spp.	11	10
K.pneumonia+ *C.albicans*	1	0.9	*S.Aureus*	12	11
K.pneumonia+ MRSA	1	0.9	MRSA	15	13.7
K.pneumonia+ *S.aureus*+ *E.coli*	1	0.9	*Enterococcus* spp.	4	3.6
K.pneumonia+ *S.aureus*+ *Psudomonas*spp.	3	2.7	*Enterobacter*spp.	7	6.4
K.pneumonia+ *S.aureus*+ BHS	1	0.9	*E.coli*	1	0.9
K.pneumonia+ *S.aureus*+ *Enterococci* spp.	2	1.8	*S.maltophilia*	1	0.9
K.pneumonia+ *Pseudomonas* spp.+ *E.coli* + *A. fumigatus*	1	0.9	*Acenitobacter*spp.	1	0.9
K.pneumonia+ *Enterobacter* spp. + *C.albicans*	1	0.9	*C.albicans*	3	2.7
Pseudomonas spp. + *S. aureus*	1	0.9			
Pseudomonas spp. + *E. coli*	1	0.9			
Pseudomonas spp. + MRSA	3	2.7			
Pseudomonas spp. + *P.misabilis*	1	0.9			
Pseudomonas spp. + *C. albicans*	7	6.4			
Pseudomonas spp. + *A. fumigatus*	1	0.9			
Pseudomonas spp. + *Candida* spp. + *Enterococci* spp.	4	3.6			
Pseudomonas spp. + MRSA + *Enterobacter* spp.	1	0.9			
Pseudomonas spp. + *E. coli* + *Enterococci* spp.	3	2.7			
Pseudomonas spp. + *E. coli* + *C.albicans*	1	0.9			
S.aureus+*C.albicans*	1	0.9			
S.aureus+*Enterobacter*spp.	1	0.9			
S.aureus+ *Enterococci* spp.	1	0.9			
S.aureus+BHS	1	0.9			
S.aureus+ *E. coli* +*P.misabilis*	1	0.9			
*Enterobacter*spp. + *S.paucimobilis*	1	0.9			
*Enterobacter*spp. + *C.albican*	1	0.9			
*Enterobacter*spp. + *Enterococci* spp.	1	0.9			
Enterococci spp. + *C.albican*	2	1.8			
Enterococci spp. + *E.coli*	1	0.9			
MRSA + BHS	1	0.9			
MRSA + *S.pneumonia*	1	0.9			
*Acinetobacter*spp. +*C.albicans*	1	0.9			
E.coli+ *S.maltophilia*	1	0.9			
Total	51	46		58	53

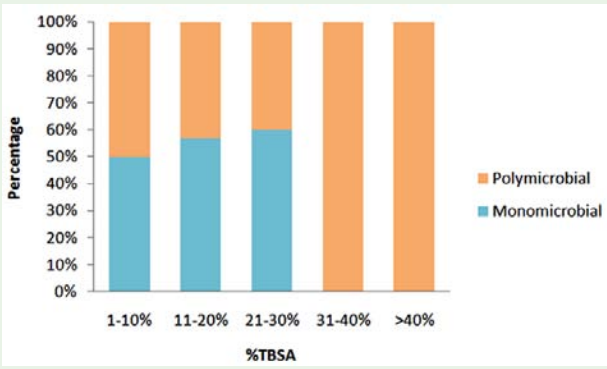

Figure 1: Age-wise distribution of type of microorganism. Polymicrobial organisms were mainly present in patients of all age groups but maximally in age >30 years. Monomicrobial organisms were present in age <30 years.

Majority of the patients had 2nd degree burns (74.3%, n=26) followed by 3rd degree (17.1%, n=6) and 1st degree burns (8.6%, n=3). The predominant cause of burn among the patients were flame (n=11, 28.9 %), followed by thermal (n=10, 26.3%), scald (n=9, 23.7%), electric (n=2, 5.3%) and others (n=2, 5.3%). The cause of burn in female was majorly hot liquid (scald burn, 41%) while in males, flame was the main cause of burn (36.4%). In children and adolescents (<15 years), scald (41.7%) and thermal (41.7%) burn were equally prevalent while in adults (>15 years) flame (40.9%) was the major cause of burn, see Table 1.

A total of 126 wound swabs were collected from 35 patients. The overall percentage of positive cultures was 86.5% in comparison to the no growth 13.5% (Table 2). Total number of swabs collected per patient was considerably increased with increase in the duration of hospital stay (Pearson's coefficient (r)=0.814, p<0.001). Single isolates were found in 58 (46%) samples while more than one isolates were found in 51 (40.5%) samples (Table 2). With TBSA >30%, polymicrobial growth prevailed (p=0.05, Figure 1). As the length of stay in hospital increased, an increased tendency of being infected with more than one type of microorganisms was observed (Pearson's coefficient (r)=0.307, p=0.07). New table is necessary to cross tabulate the mon/polymicrobials versus age, sex, length of stay, TBSA, swab rank, etc…

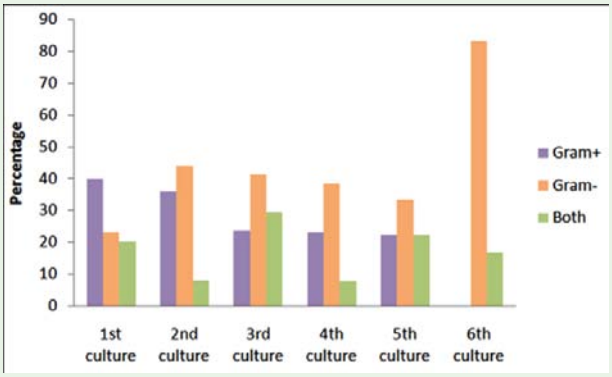

Figure 2: Temporal prevalence of Gram+/- microorganism. Gram+ bacteria were prevalent in initial swab culture which was gradually replaced by Gram- bacteria. However, mix of Gram+ and Gram- bacteria were present from initial till last culture.

Table 4: Isolation pattern of microorganism from wound swab at different time period.

Microorganisms	Culture 1		Culture 2		Culture 3		Culture 4		Culture 5		Culture 6	
	N	%	N	%	N	%	N	%	N	%	N	%
S.aureus	12	25.5	5	14.7	3	11.1	1	6.6	1	7.7	1	11.1
Pseudomonas spp.	4	8.5	5	14.7	6	22.2	4	26.2	3	23	3	33.3
MRSA	3	6.3	4	11.7	5	18.5	2	13.3	2	15.3	1	11.1
K.pneumonia	4	8.5	4	11.7	1	3.7			2	15.3	1	11.1
BHS	2	4.3					1	6.6	1	7.7		
Enterobacter spp.	7	14.9	3	8.8	2	7.4	1	6.6				
A. fumigatus	1	2.1	1	2.9								
Enterococci spp.	7	14.9	3	8.8	4	14.8	1	6.6	2	15.3		
C.albicans	2	4.3	4	11.7	3	11.1	4	26.6	1	7.7	1	11.1
S.maltophilia	1	2.1	1	2.9								
*Acinitobacter*spp.	1	2.1			1	3.7						
S. pneumoniae	1	2.1										
P.misabilis	1	2.1	1	2.9								
E.coli	1	2.1	3	8.8	1	3.7			1	7.7	2	22.2
S.paucimobilis					1	3.7						
Total	47	100	34	100	27	100	15	100	13	100	9	100

The initial swab had mostly monomicrobial growth (n=16, 45.7%) of Gram+ type (n=14, 40%) which were replaced by Gram- type (n=11, 31.4%) in second swab culture, the time of which varied from 1 day to 1 month. The Gram- bacteria remained the dominant bacterial type thereafter (Figure 2). Of the total, fungal infection was present in only 9 patients (25.7%). From 126 wound swabs, fungal isolates were present in 23 (18.3%) cases. New table or graph is necessary to associate G+ve/-ve with swab rank and other variables.

A total of 156 bacterial isolates were obtained. Among them, Gram- bacteria, Pseudomonas (24.4%) was maximally isolated followed by Gram+ bacteria *Staphylococcus aureus* (16.03%) and MRSA (14.1%) (Figure 3). MRSA (N=15) was the dominating species in monomicrobial isolates, followed by *Staphylococcus aureus* (n=12) and *Psedomonas* (n=11) (Table 3). In polymicrobial isolates, Pseudomonas (n=28) was maximally isolated followed by *K.pneumonia* (n=13) and *Staphylococcus aureus* (n=13). Other low prevailing mono- and polybacterial isolates is shown in Table 1. The

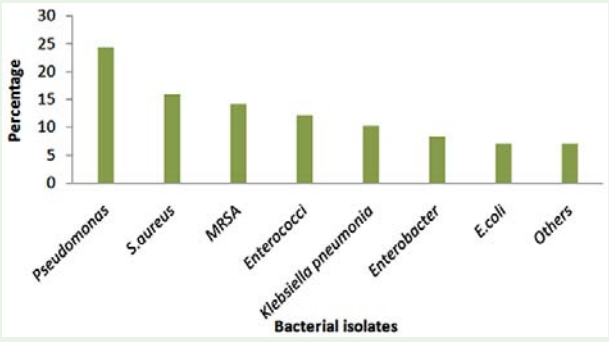

Figure 3: Prevalence of bacteria in burn wounds. Gram- bacteria Pseudomonas was the most dominant bacteria isolated in burn wounds ($p<0.001$).

fungal and yeast infection was found in 20% (n=7) and 2.9% (n=1) of the patients respectively. The only fungal species isolated was *Candida albicans* (n=22) while Aspergillus (n=2) was the only mold isolated. *Candida* was isolated with Pseudomonas in highest frequency.

Gram + bacteria *Staphylococcus aureus* (2 %), Enterococci (14.9%) and Gram- bacteria Enterobacter (14.9%) were more prevalent in 1st swab taken immediately on admission. In 2nd swab culture, *Staphylococcus aureus* (14.7 %), Pseudomonas (14.7%), MRSA (11.7%), Klebsiella pneumonia (11.7%) and Candida (11.7%) were the dominant species. From 3rd culture onwards, Pseudomonas remained the dominant species (Table 4). Candida (n=2) and Aspergillus (n=1) infection could be detected very early (culture 1) in wound swabs (Table 2). Based on our hospital management policy, 40% (n=14) of the patients had acquired healthcare associated infection which consists primarily of *Klebsiella pneumonia*, *Pseudomonas*, *Staphylococcus aureus*, *E.coli*, and MRSA. Presence of nosocomial infection was inversely proportional to the length of stay in hospital (Pearson's coefficient (r)=-0.418, p=0.012).

Discussion

Burn wound sepsis related complications remain the main cause of mortality and morbidity in burn patients. Ekrami and Kalantar [9] have reported a high incidence (82.2%) of sepsis in burn patients. Similarly, Al-Taie et al [10]. have shown an incidence of 89% of wound infections in burn patients. In contrast, our study showed an incidence of only 11.8% of sepsis in burn patients which is much lowers than the above two studies. Further, the healthcare associated infection in our study was approximately 5% which is lower than that reported by Ekrami and Kalantar [9] was (77.3%). This lower incidence of sepsis in burn patients in our study could be attributed to strict isolation techniques and infection prevention and control policies of our hospital.

Burn wounds consisting of necrotic tissue and protein rich exudates provide an excellent growth medium for multiplication of microorganisms and hence are more susceptible to microorganism invasion [11]. Additionally, compromised immune system in burn patients and longer hospital stay helps in perpetuating the growth of microorganisms. Wound infections in such patients are so fast that even after thorough cleaning with antimicrobial solution; microorganisms were isolated from most of the wounds on 1st culture made immediately on admission [12,13]. On the same note, 86.5% of swabs collected were positive for microorganisms in our study. In the present research, polymicrobial pattern of growth was considerably associated with length of hospital stay which is in agreement with study by Altoparlak et al [14].

A great disparity is observed in dominance of gender in burn units of different geographical regions of the world. In countries where female predominantly work in kitchen, a prevalence of female patients is seen in the burn units as there is more chances of getting burn due to flame or hot water and objects [15,16]. According to research by Al-Aali [1], in our study also, males were predominantly admitted to burn unit. This can be attributed to the study setting which is a military hospital with male dominance.

Saha et al. [17] have reported initial prevalence of Gram+ bacteria in burn wounds which is gradually superseded by Gram- opportunistic bacteria having more proclivities to invade. Accordingly in our study, Gram+ *S.aureus* were most frequently isolated on 1st day of hospital admission. On second swab culture, Gram+, *S.aureus* and Gram- bacteria, Pseudomonas, were equally prevalent. From third culture onwards, Pseudomonas continued to be the most prevalent microorganisms.

Burn wounds are considered sterile however, infection is mostly acquired in burns wounds while patient transportation in combat cases and while staying in hospital which are mostly unavoidable [18]. Chances of being infected with nosocomial microorganisms increases as the duration of hospital stay increases [19]. On the contrary, our study showed a negative correlation between healthcare associated infection and duration of stay in hospital. Further, according to our hospital policy, *Klebsiella pneumonia*, *S.aureus*, MRSA, Pseudomonas, and *E.coli* constitute the major nosocomial microorganisms. Presence of all of these microorganisms in 1st swab culture indicates that either the patients infected with them have been transported from other hospitals from where the infection is carried or presence of these organisms in high numbers in our hospital. The hospital management should focus in controlling these microorganisms.

Fungal infections tend to appear later in microbial invasion of burn wounds and was associated with longer duration of hospitalization [20,21]. Candida is the most common nosocomial fungal infection reported [22]. Nonetheless, in our study, infection with Candida and Aspergillus was seen as early as day 1. Further, Candida was isolated mostly with Pseudomonas. This should be taken into consideration while determining the treatment regime in burn patients of our hospital.

Conclusion

Approximately half of the infections acquired by the burn patients were hospital associated. Gram negative bacteria were the dominating bacterial type in the burn patients during the study period specially, *Pseudomonas. S. aureus* and MRSA were the major Gram positive bacteria while Candida was the main fungi identified in our burn patients. The findings of this study will aid in designing useful guideline for deciding the effective therapy for burn patients in our hospital. Further studies, evaluating antimicrobial resistance pattern in these microorganisms is however warranted.

References

1. AL-Aali KY. Microbial Profile of Burn Wound Infections in Burn Patients, Taif, Saudi Arabia. Arch Clin Microbiol. 2016; 7: 2.
2. Macedo JLS, Rosa SC, Castro C. Sepsis in burned patients. Rev Bras Med Trop. 2003; 36: 647-652.
3. Mundhada, SG, Waghmare, PH, Rathod, PG, Ingole, KV. Bacterial and fungal profile of burn wound infections in Tertiary Care Center. Indian J Burns. 2015; 23: 71-75.
4. Kumar A, Kashyap B, Mishra S. Bacteriological analysis and antibacterial resistance pattern in burn sepsis: An observation at a tertiary care hospital in east Delhi. Infect Dis Clin Pract. 2011; 19: 406-412.
5. Shi MM, Zhao DM, Wang Q, Cheng J, Ma T, Xu YH et al. Analysis of drug resistance and risk factors of Enterobacteriaceae in burn units. Zhonghua Shao Shang ZaZhi. 2010; 26: 199-201.
6. Zorgani A, Franka RA, Zaidi MM, Alshweref UM, Elgmati M. Trends in nosocomial bloodstream infections in a burn intensive care unit: An eight-year survey. Ann Burns Fire Disasters. 2010; 23: 88-93.
7. Rosenblatt-Farrell N. The landscape of antibiotic resistance. Environ Health Perspect. 2009; 117: A244-A250.
8. Chan M. Antimicrobial resistance in the European Union and the World. Conference on Combating Antimicrobial Resistance. Time for action. Copenhagen. Denmark. March 2012.
9. Ekrami A, Kalantar E. Bacterial infections in burn patients at a burn hospital in Iran. Indian J Med Res. 2007; 126: 541-544.
10. Al-Taie LH, Hassan S, Al-Mayah K Sh,Talib S. Isolation and Identification of Bacterial Burn Wound Infection and Their Sensitivity to Antibiotics. Al-Mustansiriyah J Sci. 2014; 25: 17-24.
11. Heggers JP, McCoy L, Reisner B, Smith M, Edgar P, Ramirez RJ. Alternate antimicrobial therapy for vancomycin-resistant enterococci burn wound infections. J Burn Care Rehabil. 1998; 19: 399-403.
12. Srinivasan S, Varma AM, Patil A, Saldanha J. Bacteriology of the burn wound at the BaiJerbaiWadia Hospital for children, Mumbai, India - A 13-year study, Part I-Bacteriological profile. Indian J Plast Surg. 2009; 42: 213-218.
13. Modi S, Anand AK, Chachan S, Prakash S. Bacteriological profile and antimicrobial susceptibility patterns of isolates from burn wounds at a tertiary care hospital in Patna. J Evol Med Dent Sci. 2013; 2: 6533-6541.
14. Altoparlak U. Erol S. Akcay MN. Celebi F. Kadanali A. The time-related changes of antimicrobial resistance patterns and predominant bacterial profiles of burn wounds and body flora of burned patients. Burns. 2004; 30: 660-664.
15. Panjeshahin M, Lari A, Talei A, Shamsnia J. Alaghehbandan R. Epidemiology and mortality of burns in the South West of Iran. Burns. 2001; 27: 219-226.
16. Rajbahak S, Shrestha C, Singh A. Bacteriological changes of burn wounds with time and their antibiogram. Scientific World. 2014; 12: 12.
17. Saha SK, Muazzam N, Begum SA. Chowdhury A. Islam MS. Parveen R. Study on Time-related Changes in Aerobic Bacterial Pattern of Burn Wound Infection Faridpur. Med Coll J. 2011; 6: 41-45.
18. D'Avignon LC, Saffle JR, Chung KK, Cancio LC. Prevention and management of infections associated with burns in the combat casualty. J Trauma. 2008; 64: 277-286.

Citation: Dahag MA, Louri NA, Dey N and Philip SS. Pattern of the Burn Wounds Infections in Bahrain Defence Force Military Hospital. Ann Burns and Trauma. 2018; 2(1): 1007.

19. Cosgrove SE. The relationship between antimicrobial resistance and patient outcomes: mortality, length of hospital stay, and health care costs. Clinical Infectious Diseases. 2006; 42: 82-89.

20. Bruck HM, Nash G, Stein JM. Lindberg RB. Studies on the occurrence and significance of yeasts and fungi in the burn wound. Ann Surg. 1972; 176: 108-110.

21. Ramzy PI, Wolf SE, Irtun O, Hart DW. Thompson J, Herndon DN. Gut epithelial apoptosis after severe burn: effects of gut hypoperfusion. J Am Coll Surg. 2000; 190: 281-287.

22. Macedo JLS. Imunodepressão do queimado: patogênese e fator de riscoparasepse. Rev Bras Queimadura. 2003; 3: 26-35.