Original Article

Microbiological analysis and anti-microbial selection in a Burn centre of a Tertiary Care

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Abstract

Background: Burn wound is often complicated by infection resulting in significant patient morbidity and mortality. This study aimed to analyse various micro-organisms encountered and their antimicrobial susceptibility in a tertiary care centre to guide the empirical therapy. **Materials and Methods:** This prospective study of 62 patients with > 1st degree burns, > 5% Body surface area on zero post-burn day. Patients were evaluated for various infections using surface swabs and wound biopsy. Blood, urine and sputum culture were done if infection suspected and were sent for microbiological assessment. **Results:** Majority of patients enrolled were young males (77%). Mostly (92%) patients were managed conservatively. Mean duration of hospital-stay was 11 days. 29(46.8% patients had ≤ 25% burns. Majority (49%) patients were discharged, 33.9% left against medical advice. Flame burns were commonest (58.1%). Majority (51.6%) patients had third degree burns. Around 75.8% patients received topical Silver Sulfadiazine. Pseudomonas aeruginosa and Acinetobacter baumannii and species were most commonly encountered in wound swab and tissue biopsy. Urine culture revealed mainly Escherichia coli (8%). Polymyxin –B, Piperacillin/Tazobactam, Colistin, Cefoperazone/sulbactam and Teicoplanin were most sensitive anti-microbials. Eleven (18%) patients succumbed to their burns revealing infections mainly due to Pseudomonas aeruginosa, Enterobacter cloacae, MRSA and Escherichia coli. **Conclusion:** Pseudomonas aeruginosa and Acinetobacter baumannii were insensitive to common anti-microbials and sensitive to higher ones. The surging antimicrobial- susceptibility tide displayed by the microbial pathogens pose a major threat and hinderance in burn wound management. Therefore, implementation of antimicrobial stewardship and knowledge of the evolving pattern of sensitivity is crucial.

Keywords: Burn, Infection, Culture, Microorganisms, Anti-Microbial Susceptibility.

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Introduction

Burns is a category of injury, which is caused by inadvertent exposure to high temperature in the form of liquid, solid, or gas such as hot drinks, smoke, steam, contact with hot appliances, tools or any object radiating heat.[1] Worldwide, in the year 2019, around 8,378,122 new cases of burns were identified.[2] Approximately 7 million burn injuries happen annually in India. India has earned the title of being the "burn capital of the world" owing to highest incidence of burn injuries.[3,4] This high incidence can be attributed to low literacy rate, low socio-economic status and minimal safety. Burn injury can also be a result of ultraviolet/infrared radiation, electric current or exposure to harmful chemicals.[5]

Skin barrier's thermic disruption and parallel impairment of the localised as well as systemic host cell-mediated and humoral defence mechanisms subsequently increase vulnerability to get infected resulting in delayed healing, thick scar formation, prolonged hospital stay and higher mortality due to hospital acquired infections as well.[6,7]

Regardless of the significant developments in burn wound care, various infections such as infection of the wound, urine, respiratory system and bloodstream continue to be a major cause of morbidity and mortality.[8] Various studies suggest differently, some report pneumonitis while some suggest sepsis as the notable infection syndrome observed in burn patients.[9]

Gram- positive organisms predominate the wound in the initial stages of injury. Current research suggests Staphylococcus spp. followed by Pseudomonas aeruginosa, Enterococcus spp., Escherichia coli, Klebsiella pneumoniae and Proteus spp. in burn wounds,[10] Whereas pneumonia encountered is mainly due to Pseudomonas aeruginosa initially and subsequently commensal species. E-coli and Proteus mirabilis are the main offenders identified from urine cultures due to frequent urinary catheterisation. However, bacteraemia due to Bacillus sp., Propionibacterium sp., coagulase negative Staphylococci, or

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Candida albicans is the most lethal.[11-13]

Recently, an upsurge has been observed in the incidence of infections owing to rarely encountered micro-organisms, as well as the multidrug-resistant strains of the common ones. Infection can be suspected clinically which can be confirmed through investigations such as blood, urine, tissue and sputum cultures. Burn wounds in general are assessed qualitatively and semi-quantitatively employing swab cultures.[14-16]

The developing countries like India have an ever-growing incidence of burn wounds related complications and mortality owing to poor socio-economic status, surplus population, lower literacy rate and inaccessibility to state of the art burn management. Numerous studies assessed the microbiological pattern of infections in Burn patients globally as well as in India.[17,18] However, it has been observed that the prevalence of microbial infection varies between developed and developing countries, various health care set ups and during different time periods. Often the treatment in burns is empirical therefore this research was designed to provide a useful insight into the burden of infections, the prevalent antimicrobial- sensitivity pattern and subsequently be of service in curbing antimicrobial resistance and formulating and strengthening the antimicrobial stewardship program currently in practice.

Materials and Methods

Patients: This prospective, open label study of 62 burn patients admitted in the Burn unit of Plastic Surgery department was approved by the institutional research and ethics committee and patient informed consent was obtained. Sample size determination was done using the below mentioned formula with adding 10% extra for loss to follow up.

$n = Z^2P(1-P)/d^2$

Where, n=sample size; Z=confidence level=1.96 (for confidence interval 95%); P=expected prevalence=15%; d=precision=0.01

Wound Treatment: All the patients enrolled received daily basis closed dressings using ointments. The various ointments employed such as Silver Sulfadiazine, Mafenide, Silver nitrate, Bacitracin, Mupirocin, Neosporin, Nitrofurazone and Nystatin were used alternatively and inter-changed in case of development of serious adverse events.[19]

All patients had their wound cultures and sensitivities done at the time of admission prior to any cleaning while subsequent samples are taken post cleaning previous day's remnant ointment. The aseptic sampling involved both the wound swabs (surface smears) along with tissue biopsy cultures. Surface swabs tend to be more sensitive for detecting colonizing bacteria, while tissue biopsies are better at identifying causative pathogens and measuring bacterial load. Utilising Levine's technique,[20] were taken from areas which seemed deeper, discharging, or having a thick eschar avoiding contaminated genito -urinary zones on day zero followed by day 1,3,5,7 and then weekly till healing of wounds surgically or spontaneously or discharge of patient. Simultaneously, utilising Loebl's technique,[21] 3rd degree burns with eschar in non- contaminated areas were biopsied and sent for culture.[22] Blood sample for culture and sensitivity was collected via a venipuncture on day 1 and day 3 and in addition whenever the patient developed fever or other signs and symptoms suggesting systemic infection.[23] Urine culture was sent on day 1,3,5,7 and in all patients admitted and when patients required urinary catheterization.[24] Sputum sample for culture was sent if and when symptoms like cough and expectoration developed.[25] Post-inoculation on suitable culture media, the collected specimens were incubated for 24 hours at temperature of 37°C for obtaining aerobic and anaerobic colonies.[26] The micro-organisms were identified as per their morphology and peculiar biochemical analysis.[27] Antibiotic susceptibility testing of isolate was done on Muller Hinton agar using Kirby-Bauer disc diffusion method.[28]

Inclusion Criteria,[29,30]

1. Patients with > 1st degree burns and a minimum of 5% BSA (body surface area) and zero post burn day
2. Patients with thermal burns, electrical burns, contact chemical burns or scalds

Exclusion Criteria,[31]

1. Patients unwilling to participate in the research
2. Patients presenting with old (late presentation) burns
3. Immunocompromised patients (due to disease such as HIV or medication) in the preceding 6 months.

Statistical Analysis:

Descriptive and Inferential statistics were employed for this research such as proportions and Chi-square. Data presentation tools such as Pie charts and bar - diagrams were employed to convey the research findings. The level of significance chosen was $p<0.05$.

Results

Demographic Profile of patients

Mean age of the patients was 30±14.8 years. Majority, 48 (77.4 %) were men and were conservatively managed i.e. 57(91.9%). Mean duration of hospital- stay was 10.8 ±13.05 days. Concerning surface area, most of them 29(46.8%) had ≤ 25% burns. Final Outcome of the majority, 30 (48.4%) of in-patients was being discharged in a satisfactory condition, however 21(33.9%) went LAMA (Leave against medical advice) and 11(17.7%) succumbed to burns. Flame burns were the commonest, 36(58.1%) aetiology while chemical medicated burns were least observed i.e. 3(4.8%). Third degree burns were most commonly observed 32(51.6%) followed by second degree i.e. 28 (45.2%) and least were fourth degree 2(3.2%).

Local Anti-microbials used

Majority of the patients were topically administered silver sulfadiazine 40(64.5%) followed by Neosporin i.e. 14 (22.5%), mupirocin in 4(6.4%) while 2(3.2%) each received betadine and nitrofurazone. More than one type of ointment was frequently employed in numerous patients. The most frequently prescribed systemic anti-microbial was Amikacin 52(83.9%), followed by Cefoperazone - Sulbactam 40 (64.5%) and Ampicillin 38 (61.3%). The frequency of usage of locally applied antimicrobials is mentioned in [Table 1].

Table 1: Anti-microbials used locally

Anti-microbial	Number of Patients (n)	Percentage (%)
Local anti-microbials		
Silver sulfadiazine	40	64.5
Neosporin	14	22.5
T-Bact	4	6.4
Betadine	2	3.2
Nitrofurazone	2	3.2

Organisms Grown

a) In wound swab culture and tissue culture

Majority of the samples sent on the first day showed no growth. Out of 60 patients 220 isolates were identified in wound swabs while 190 in tissue culture. In both the wound swab and tissue biopsy ten different bacterial isolates were identified with the predominant bacteria being Pseudomonas spp., followed by Acinetobacter baumannii, and Staphylococcus aureus (MRSA) both in wound surface swabs and tissue biopsies. Fungal isolates were also identified in both the wound surface swabs and tissue biopsy cultures. The organisms present in wound swab and tissue biopsy culture on day 1,3,5,7 and then weekly have been summarised and are collectively depicted in Table 2.

Out of the 190 isolates in wound swabs, 88.42% (n=168) and out of 220 isolates in tissue biopsies, 87.72% (n=193) were mono-bacterial whereas were 11.57% and 12.27% were multi-bacterial in wound swab and tissue biopsy respectively.

Table 2: Organisms isolated in wound swab and tissue culture

Isolated organisms	Number of isolates (%) (wound swab) N = 190	Number of isolates (%) (tissue culture) N= 220
Gram Positive Isolates		
MRSA	21(11.05)	22 (10)
MSSA	6 (3.1)	9 (4)
Enterococcus spp.	9 (4.7)	8 (3.6)
Gram Negative Isolates		
Pseudomonas aeruginosa	53 (27.8)	67 (30)
Acinetobacter baumannii	46 (24.2)	54 (24.5)
Enterobacter cloacae	10 (5.2)	19 (8.6)
Escherichia coli	20(10.5)	15 (6.8)
Klebsiella pneumoniae	10 (5.2)	14(6.3)
Proteus vulgaris	3 (1.5)	6 (2.7)
Proteus mirabilis	3 (1.5)	0 (0)
Fungal Isolates		
Candida albicans	9 (4.7)	3 (1.3)
Non-albicans Candida species (NAC)	0 (0)	3 (1.3)

b) In urine and blood culture

The organisms seen in urine and blood culture are depicted in [Figure 1]. Mostly, patients in urine had *Escherichia coli* as the invading organism. Out of 62 patients of Burns, it had been necessary to carry out blood culture in 8 patients, in which 4 cultures were positive and 4 were negative for microbial growth. Acinetobacter was most predominant in blood samples sent.

c) Anti-microbial sensitivity

- The anti-microbial sensitivity in wound swabs and tissue culture is depicted as follows in [Table 3 and 4] respectively.

Disc-diffusion susceptibility testing indicated a high prevalence of resistance to various antimicrobial agents. Hinderance in interpretation of sensitivity pattern of antifungal drugs such as ketoconazole and amphotericin B was there owing to deficiency in guidelines on interpretation of zone of inhibition for antifungal disc diffusion methods.

The sensitivity pattern of the various isolated micro-organisms in wound swab and tissue biopsy culture is depicted in [Table 3 and 4] respectively.

Table 3: Antimicrobial sensitivity (Percentage) of organisms isolated in wound swab culture

Anti-microbial	S (n=31)	E (n=8)	PA (n=67)	AB (n=54)	EC (n=19)	ECo n=15)	KP (n=14)	P (n=6)
Piperacillin + Tazobactam	97.2	54.7	94.2	NT	61.2	83.4	35.6	86.2
Polymyxin B	90.2	65.3	90.3	92.3	93.2	87.5	88.6	99.8
Amikacin	65.2	78.3	6.7	78.9	89.2	85.3	87.8	38.2
Gentamicin	68.3	22.1	7.2	36.3	37.3	78.7	68.6	30.5
Moxifloxacin	81.6	63.6	38.2	61.3	23.9	45.7	12.8	67.8
Ciprofloxacin	22.3	46.7	32.1	36.2	74.3	26.4	34.9	50.5
Meropenem	92.3	70.1	67.5	58.1	90.3	57.9	34.7	67.9
Imipenem	90.1	91.6	89.7	89.7	56.1	78.9	77.6	78.3
Colistin	NT	NT	95.4	94.4	90.5	89.9	59.8	92.3
Netromycin	83.7	NT	52.1	63.1	80.1	58.9	58.6	40.3
Cefoperazone- sulbactam	89.2	NT	89.2	93.2	89.1	82.4	38.7	69.2
Cefotaxime	88.2	34.8	46.2	60.1	42.1	88.9	86.5	7.8

Ceftriaxone	73.8	33.5	12.4	68.9	53.3	78.9	84.2	48.8
Ceftazidime	89.5	37.8	36.4	66.7	45.4	32.1	80.9	69.7
Aztreonam	NT	NT	36.1	32.5	67.2	37.2	68.8	10.3
Vancomycin	72.8	77.1	18.1	NT	79.7	NT	48.9	58.8
Teicoplanin	95.8	67.3	NT	NT	80.3	NT	NT	NT
Linezolid	90.5	92.3	NT	NT	78.1	NT	NT	56.5
Levofloxacin	89.1	78.9	55.1	12.4	56.7	57.9	90.1	37.9
Cloxacillin	32.7	NT	NT	NT	NT	14.8	NT	NT
Amoxicillin -clavulanic acid	59.9	93.1	12.1	4.1	NT	20.3	NT	NT

S- *Staphylococcus spp.*, **E**- *Enterococcus sp.*, ***PA***- *P. aeruginosa*, ***AB***- *A. baumannii*, ***EC***- *E. cloacae*, ***ECo***- *E. coli*, ***KP***- *K. pneumoniae*, ***P***- *Proteus spp.*, **NT**=Not tested.

Table 4: Antimicrobial sensitivity (Percentage) of organisms isolated in tissue culture

Anti-microbial	S (n=31)	E (n=9)	PA (n=67)	AB (n=54)	EC (n=19)	ECo n=15)	KP (n=14)	P (n=6)
Piperacillin + Tazobactam	95.2	49.7	93.2	NT	63.2	80.4	37.6	84.2
Polymyxin B	88.2	63.3	90.3	93.5	91.2	85.5	84.6	99.3
Amikacin	63.2	75.3	7.6	72.9	90.2	80.3	90.8	38.2
Gentamicin	66.3	20.1	7.9	40.3	41.3	82.7	68.9	30.5
Moxifloxacin	82.6	65.6	38.2	59.3	24.9	47.7	10.8	65.8
Ciprofloxacin	24.3	43.7	35.1	35.2	73.3	28.4	35.6	55.5
Meropenem	91.9	69.8	65.5	56.1	89.8	55.7	33.7	63.9
Imipenem	90.8	92.6	85.7	90.2	56.7	76.9	79.3	76.3
Colistin	NT	NT	95.4	94.4	90.5	89.9	59.8	92.3
Netromycin	81.8	NT	50.1	65.3	82.6	59.9	58.6	40.3
Cefoperazone- sulbactam	89.6	NT	88.5	92.9	88.3	81.7	39.7	67.4
Cefotaxime	87.9	32.8	50.2	61.1	44.1	90.2	87.5	7.7
Ceftriaxone	75.1	35.5	11.5	69.2	50.3	79.9	83.7	46.5
Ceftazidime	89.2	35.9	33.4	68.2	42.7	30.1	81.5	66.7
Aztreonam	NT	NT	35.1	30.8	64.2	32.6	70.5	11.3
Vancomycin	70.8	73.2	19.3	NT	78.2	NT	50.2	57.2
Teicoplanin	93.7	65.3	NT	NT	85.3	NT	NT	NT
Linezolid	90.5	92.3	NT	NT	78.1	NT	NT	53.9
Levofloxacin	91.7	73.5	54.6	16.2	54.9	57.3	92.2	37.9
Cloxacillin	30.9	NT	NT	NT	NT	16.1	NT	NT
Amoxicillin -clavulanic acid	62.1	89.9	10.1	3.5	NT	18.7	NT	NT

S- *Staphylococcus spp.*, **E**- *Enterococcus sp.*, ***PA***- *P. aeruginosa*, ***AB***- *A. baumannii*, ***EC***- *E. cloacae*, ***ECo***- *E. coli*, ***KP***- *K. pneumoniae*, ***P***- *Proteus spp.*, **NT**=Not tested.

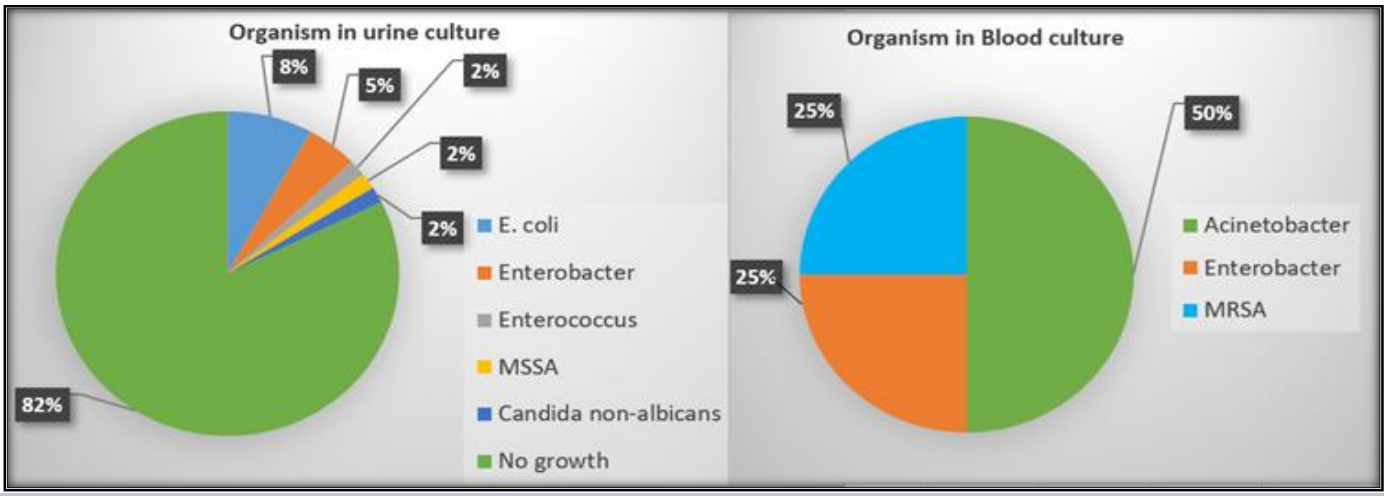

Figure 1: Organisms in urine and blood culture

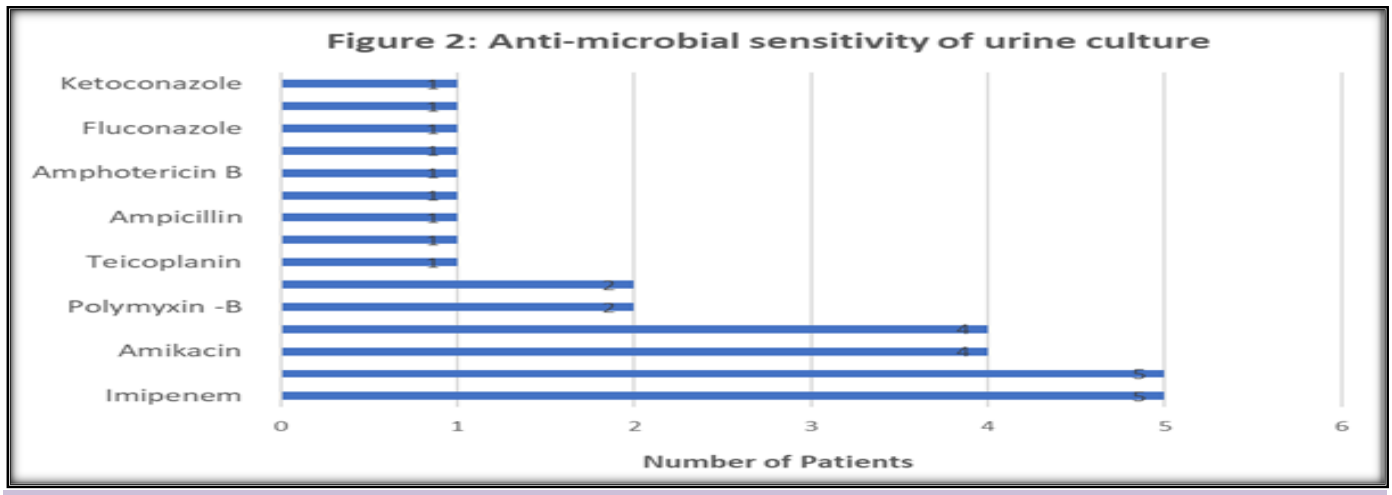

Figure 2: Anti-microbial sensitivity pattern of bacterial isolates in urine culture

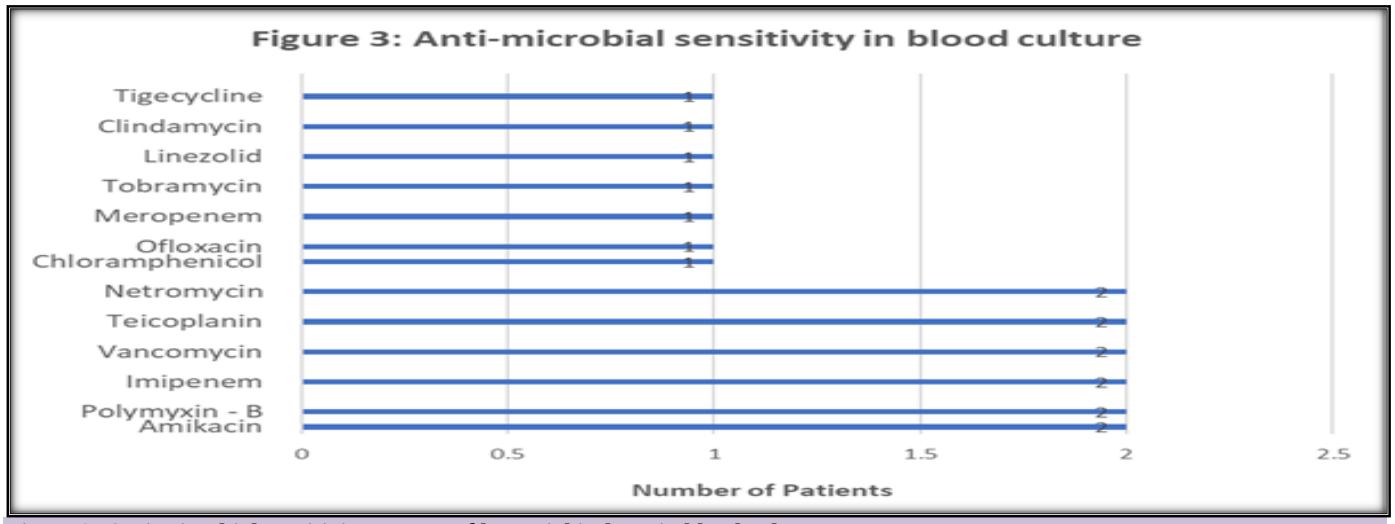

Figure 3: Anti-microbial sensitivity pattern of bacterial isolates in blood culture

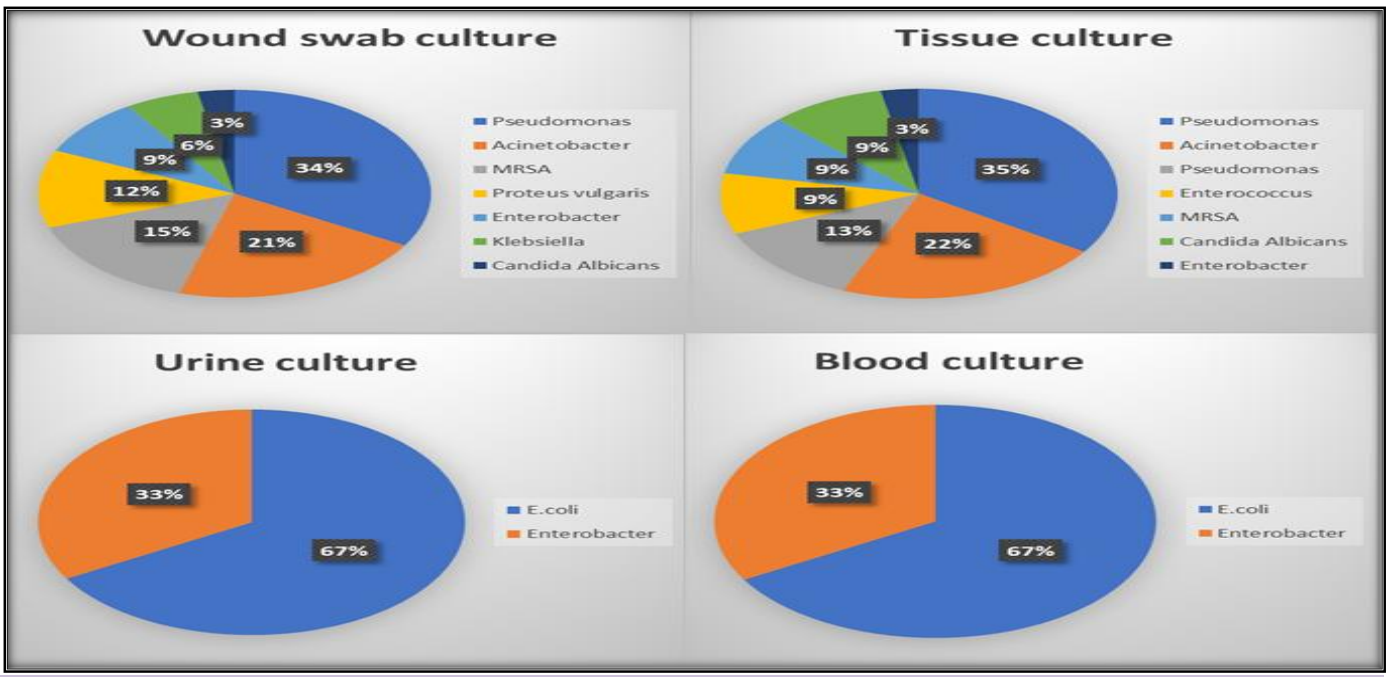

Figure 4: Organisms isolated in culture samples of patients who had mortality

- **In urine culture:** Anti-microbial sensitivity of urine culture is given in [Figure 2].
- **In blood culture:** Anti-microbial sensitivity in blood culture is given in [Figure 3].

Data in mortality patients

In this study of 62 burn patients, 30 patients were discharged in satisfactory condition, 21 patients took LAMA and 11 patients succumbed to death. The various organisms isolated from wound swab culture, tissue culture, urine and blood culture are depicted as follows in [Figure 4].

Discussion

A total of 62 patients with burns were enrolled in this research. The results were statistically analysed and compared to those of previous studies.[32]

As per our research the most affected (25.8% each) age group was revealed to be 21-30 and 31-40 years. These findings are in alignment with findings of another study where, most commonly impacted age group was 25-39 years.[33] In our study the mean age of patients was found out to be 30 years. Our findings are parallel to those from another study conducted by Vladimir and co-workers.[34] The possible rationale behind this observation could be that the people belonging to this age group are more vulnerable to burn injuries because of being more active and outgoing. In our study 77.4% patients were reported to be men while only 22.6% were women. Similar results were found in study done in Romania where 206 males and 149 females had thermal injuries.[35] In contrast to the findings in our study, in another study where the burns owing to self-immolation were more commonly observed in females rather than males.[36] Though in India, burns in ladies due to dowry/domestic violence accounts for high incidence in females, however the males being the bread winner of family and being outgoing are still more vulnerable to thermal injuries.

Around Ninety-two percent patients in our study were conservatively managed while only 8.1% patients had surgical intervention. To operate or not, and whom to operate was decided by the head surgeon. Mainly the surgical intervention was required for patients with full-thickness burns.[37] Mean duration of hospital-stay in our study in total of 21 patients who were satisfactorily discharged was 11 days. Our findings were similar to the findings in a study done at Netherlands where the mean hospital stay was of 8 days.[38] As per the findings of our research, majority of the patients had surface area involvement of ≤ 25%. Similar to the findings in our study another study done at Catalonia, Spain, observed the mean body surface area affected to be 8.3%.[39]

In our study, out of 62 patients, 48.4% of the patients were discharged, 33.9% went LAMA and 17.7% of the patients expired. Patients take LAMA as burn patients are not health insured and are often required to pay themselves due to a number of reasons, primarily due to lack of health insurance and requirement to pay for everything, prolonged hospital stay, multiple surgical procedures or need for ICU which are often there. In contrast, to findings of our study, another study observed a higher percentage of mortality in their patients, i.e. around 36%.[40] The most common (58.1%) aetiology of injury in our study was revealed to be flame burns. Second most common is electric contact burns seen in 16.1%, Scald burns in 14.5%, followed by electric flash burns in 6.5% and chemical burns in 4.8%. Similarly in an epidemiological study done, flame was the most common aetiological agent implicated in burns.[41] However, in contrast to findings of our study, another research done by Zlatan and colleagues observed scalds to be the main culprit in thermal injuries.[42]

Most (51.6%) of the patients enrolled in our study presented with third degree burns, followed by second degree (45.2%) and fourth degree (3.2%). Being a tertiary care hospital and acquiring the state of art-burn ICU, its mainly the third degree burn patients that present to our institute.

Most of first degree burn patients are managed on OPD basis and rarely require hospitalization and hence they were not included in the study. Our findings are similar to another study conducted at a tertiary care centre where 78% patients had third degree burns.[43] Another research done, however revealed second degree burns to be the commonest.[44]

Often multiple ointments were employed in numerous patients. Silver Sulfadiazine ointment was used for dressing in majority i.e. 75.8% patients. Neosporin ointment was employed in 30.6 % patients, particularly in the first degree and superficial second-degree burns. Research of more than five decades suggest that Silver-sulfadiazine has been the most commonly used topical anti-microbial agents used in burns.[45] Mupirocin was employed in 6.5% patients, particularly in the MRSA positive culture patients, as evidenced by research.[46] Amikacin, Piperacillin/Tazobactam, Cefoperazone- Sulbactam and Colistin were the most frequently utilised systemic anti-microbials. Subsequently, over the course of therapy, higher anti-microbial agents like Imipenem, Polymyxin B were given mainly in gram negative infections, while Linezolid and Teicoplanin were employed to tackle MRSA positive cultures. Other anti-microbial employed were Piperacillin/Tazobactam. Often there was a need to utilise more than one type of systemic anti-microbial agent. In recent research conducted in Iran, cefepime (40.3%) was the most frequently administered antibiotic, followed by vancomycin (17.9%) and meropenem (16.8%).[47] The anti-microbials used were decided according to the various culture/sensitivity reports obtained from time to time.

As per our research, on the day of admission, majority of the culture swabs were negative. Research also supports this fact that the burn wound surfaces to begin with are sterile but later on microbial invasion occurs.[48] The notorious multi-drug-resistant micro-organisms are the consequence of protracted utilisation of anti-microbial preparations. More than one type of organism was found to be responsible for infections in many patients. Post-hospitalisation it was observed that the incidence of infection gradually rose among which Pseudomonas aeruginosa and Acinetobacter baumannii were most

frequently demonstrated in about a week of hospitalisation. Parallel to our research findings, in another study, the most common isolate was Pseudomonas aeruginosa (24.91%), closely followed by Staphylococcus aureus (24.05%), Acinetobacter baumannii - 27 (17.09%) and Klebsiella pneumoniae - 24 (15.19%).[49]

P. aeruginosa could be the main opportunistic pathogen in the burn wards probably due to its ability to thrive in moist environment, requiring minutest nutrition, adapting to variety of physical conditions rendering it resistance to many anti-microbial agents.[50] However, recently as per research there has been a surge in Acinetobacter baumannii as an important cause of nosocomial infection in burn units. Now this could partly be a consequence of it being normal skin commensal and tendency to thrive and flourish in a multidrug-resistant scenario of a hospital environment.[51]

In our study the most common organism encountered in tissue culture Pseudomonas aeruginosa, Acinetobacter baumannii and Staphylococcus aureus. In another study, the most frequent species encountered was Staphylococcus (55.1%), followed by Pseudomonas aeruginosa (14.29%), Enterococcus spp. (12.24%) and Escherichia coli (4%).[52]

However, in another research done by Salih and co-workers, it was observed that Staphylococcus aureus was the most prevalent etiological micro-organism encountered in tissue cultures.[53]

In our study the most common organisms grown in urine were as follows: Escherichia coli -8%, Enterobacter cloacae 4.8% and Enterococcus spp. -1.6%. These research findings fall in line with findings from another study done in India where the most common microbe revealed in urine culture was Escherichia coli. In our study most common organisms grown in blood were Acinetobacter baumannii- 25% followed by Enterobacter cloacae and MRSA both 12.5%. These findings are coincident with findings of another study done in Japan, where Acinetobacter baumannii was the commonest culprit implicated in positive blood cultures.[16]

In another retrospective study of burn patients conducted over seven-year period, Pseudomonas aeruginosa was the main pathogen, followed by Staphylococcus aureus, Klebsiella pneumoniae and Acinetobacter baumannii.[54] In our research, urine culture depicted Candida albicans too. These findings are similar to findings of another research done in Baghdad revealed urine fungal culture positivity rate of 19%.[54] In our study, no patient required sputum culture. These findings are in alignment with findings from another research where the sputum culture positivity was quite low (1%).[55]

As per our research, the most sensitive anti-microbials in both wound surface and tissue cultures were Polymyxin –B, Piperacillin/Tazobactam, Colistin, Cefoperazone/sulbactam and Teicoplanin. These findings are similar to findings from another study where Tigecycline and Polymyxin-B were the most sensitive antimicrobials.[56] However, another study suggested that most-sensitive anti-microbials were colistin, cefepime, ampicillin and cefuroxime.[57]

In our study of 62 patients, 11 (18%) patients succumbed to their burns. In another study around 37% patients succumbed to thermal injury.[58] Whereas, in another study done in Saudi Arabia, burn associated mortality was 17%.[59] As per our research, the infective organisms in these patients were mainly Pseudomonas aeruginosa, Enterobacter cloacae, MRSA and Escherichia coli. In another study done analysing the pattern of infections in burn-associated mortality patients, Staphylococcus aureus, Vancomycin-resistant Enterococcus spp., Pseudomonas aeruginosa, Acinetobacter baumannii, Escherichia coli were the common pathogens involved.[60]

Conclusion

Burn injuries impact hugely resulting in significant morbidity and mortality. Regardless of the significant advances in burn care, infection continues to remain a major cause of morbidity and mortality in burn patients. Male patients, with mean age of 30 years were more affected by thermal injury. Flame burns and third-degree burns were found to be the most frequent. Topically, Silver Sulfadiazine ointment was most frequently employed for dressing the wound while systemically, Amikacin, Cefoperazone- Sulbactam and Ampicillin were utilised to counter the infections. On day of admission, both wound and tissue cultures were negative in majority of the patients, these cultures in a week became positive for Pseudomonas aeruginosa and Acinetobacter baumannii in a large number of patients which were mainly sensitive to higher anti-microbials. The surge in antimicrobial resistance and its evolving trends pose a serious threat and hinderance for the treating physicians to manage burn patients.61 There is a need for stressing on infection control practices to be mandated in the burn unit as it harbours the vast load of microorganisms. The increment in the MDR pathogens can be attributed to extended utilisation of anti-microbials, empirical use of broad-spectrum anti-microbials and non-compliance to hospital anti-microbial policy. It is of utmost importance to note that post- establishment, the MDR strains persist for months. Hence, antimicrobial stewardship incorporating diligent microbiological scrutinization prior to starting of empirical anti-microbial therapy and adhering to strict anti-microbial policy might prove to be of significance in prophylaxis and therapy of MDR isolates in burn units consequently unburdening the overall infection-associated morbidity and mortality.

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Conflicts of interest

There are no conflicts of interest.

References

1. GBD 2019 Diseases and Injuries Collaborators. Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet. 2020;396:1204-22.
2. Yakupu A, Zhang J, Dong W, Song F, Dong J, Lu S. The epidemiological characteristic and trends of burns globally. BMC Public Health. 2022;22:1596.

3. Honnegowda TM, Kumar P, Udupa P, Rao P. Epidemiological study of burn patients hospitalised at a burns centre, Manipal. Int Wound J. 2019;16:79-83.
4. Mahalingam S, Rajendran G, Rajaa S, Aazmi A, Maroju N, Purushothaman S, et al. Clinico-Demographic Profile and Factors Affecting Duration of Hospital Stay Among Burn Patients in an Emergency Department of a Tertiary Care Center, South India: A Hospital-Based Cross-Sectional Study. Cureus. 2023;15:e43397.
5. Hoogewerf CJ, Hop MJ, Nieuwenhuis MK, Oen IM, Middelkoop E, Van Baar ME. Topical treatment for facial burns. Cochrane Database Syst Rev. 2020;7:CD008058.
6. Jeschke MG, van Baar ME, Choudhry MA, Chung KK, Gibran NS, Logsetty S. Burn injury. Nat Rev Dis Primers. 2020;6:11.
7. Vinaik R, Barayan D, Shahrokhi S, Jeschke MG. Management and prevention of drug resistant infections in burn patients. Expert Rev Anti Infect Ther. 2019;17:607-19.
8. Radzikowska-Büchner E, Łopuszyńska I, Flieger W, Tobiasz M, Maciejewski R, Flieger J. An Overview of Recent Developments in the Management of Burn Injuries. Int J Mol Sci. 2023;24:16357.
9. Blears E., Sommerhalder C., Toliver-Kinsky T., Finnerty C.C., Herndon D.N. Current Problems in Burn Immunology. Curr. Probl. Surg. 2020;57:100779.
10. Lachiewicz AM, Hauck CG, Weber DJ, Cairns BA, van Duin D. Bacterial Infections After Burn Injuries: Impact of Multidrug Resistance. Clin Infect Dis. 2017;65:2130-6.
11. Sierawska O, Małkowska P, Taskin C, Hrynkiewicz R, Mertowska P, Grywalska E, Korzeniowski T, Torres K, Surowiecka A, Niedźwiedzka-Rystwej P, Strużyna J. Innate Immune System Response to Burn Damage-Focus on Cytokine Alteration. Int J Mol Sci. 2022;23:716.
12. Liao PH, Kao CC, How CK, Yang YS, Chen MC, Hung-Tsang YD, et al. Initial White Blood Cell Count and Revised Baux Score Predict Subsequent Bloodstream Infection in Burn Patients: A Retrospective Analysis of Severe Burn Patients from the Formosa Color Dust Explosion of 2015. J. Formos Med. Assoc. 2021;120:1719-28.
13. Kundu R, Das S, Chattopadhyay BP. Microbiological profile of urinary tract infection in patients with burn injuries. Int Surg J 2021;8:2695-8.
14. Mirhoseini SH, Koolivand A, Bayani M, Sarlak H, Moradzadeh R, Ghamari F, et al. Quantitative and qualitative assessment of microbial aerosols in different indoor environments of a dental school clinic. Aerobiologia (Bologna). 2021;37:217-24.
15. Markiewicz-Gospodarek A, Kozioł M, Tobiasz M, Baj J, Radzikowska-Büchner E, Przekora A. Burn Wound Healing: Clinical Complications, Medical Care, Treatment, and Dressing Types: The Current State of Knowledge for Clinical Practice. Int J Environ Res Public Health. 2022 Jan 25;19:1338.
16. Kaita Y, Otsu A, Tanaka Y, Yoshikawa K, Matsuda T, Yamaguchi Y. Epidemiology of bloodstream infections and surface swab cultures in burn patients. Acute Med Surg. 2022;9:e752.
17. Ke Y, Ye L, Zhu P, Zhu Z. The clinical characteristics and microbiological investigation of pediatric burn patients with wound infections in a tertiary hospital in Ningbo, China: A ten-year retrospective study. Front. Microbiol. 2023;13:1034099.
18. R E, Princess I, Vadala R, Kumar S, Ramakrishnan N, Krishnan G. Microbiological Profile of Infections in a Tertiary Care Burns Unit. Indian J Crit Care Med. 2019;23:405-410.
19. Saeidinia A, Keihanian F, Lashkari AP, Lahiji HG, Mobayyen M, Heidarzade A, et al. Partial-thickness burn wounds healing by topical treatment: A randomized controlled comparison between silver sulfadiazine and centiderm. Medicine (Baltimore). 2017;96:e6168.
20. El Hamzaoui N, Barguigua A, Larouz S, Maouloua M. Epidemiology of burn wound bacterial infections at a Meknes hospital, Morocco. New Microbes New Infect. 2020;38:100764.
21. Srinivasan S, Saldanha J, Abhyankar S, Patil A, Vartak AM. Bacteriology of the burn wound at the Bai Jerbai Wadia hospital for children, Mumbai, India-A 21 year study of predominant Pseudomonas aeruginosa species. Int J Burns Trauma. 2018;8:98-105.
22. Halstead FD, Lee KC, Kwei J, Dretzke J, Oppenheim BA, Moiemen NS. A systematic review of quantitative burn wound microbiology in the management of burns patients. Burns. 2018 Feb;44(1):39-56.
23. Almajidy AK, Jasim AK, Almajidy RK. Analysis Of Blood Culture Results Of Burn Septicaemia Patients Over A Period Of Nine Years In The Baghdad Burn Medical Centre. Ann Burns Fire Disasters. 2020 Mar 31;33(1):27-32.
24. Werneburg GT. Catheter-Associated Urinary Tract Infections: Current Challenges and Future Prospects. Res Rep Urol. 2022 Apr 4;14:109-133.
25. Naidus EL, Lasalvia MT, Marcantonio ER, Herzig SJ. The Diagnostic Yield of Noninvasive Microbiologic Sputum Sampling in a Cohort of Patients with Clinically Diagnosed Hospital-Acquired Pneumonia. J Hosp Med. 2018 Jan 1;13(1):34-37.
26. Giuliano C, Patel CR, Kale-Pradhan PB. A Guide to Bacterial Culture Identification And Results Interpretation. P T. 2019 Apr;44(4):192-200.
27. Borman AM, Mohammed S, Palmer MD, Childs N, Johnson EM. The importance of appropriate processing and direct microscopic examination for the timely diagnosis and management of invasive infections caused by filamentous fungi. Med Mycol. 2022 Dec 7;60(12): myac081. doi: 10.1093/mmy/myac081.
28. Yin D, Guo Y, Han R, Yang Y, Zhu D, Hu F. A modified Kirby-Bauer disc diffusion (mKB) method for accurately testing tigecycline susceptibility: a nation-wide multicenter comparative study. J Med Microbiol. 2023 Aug;72(8).
29. Tsolakidis S, Freytag DL, Dovern E, Alharbi Z, Kim BS, Houschyar KS, Reumuth G, Schäfer B, Rennekampff HO, Pallua N, Grieb G. Infections in Burn Patients: A Retrospective View over Seven Years. Medicina (Kaunas). 2022 Aug 8;58(8):1066.
30. Wu H, Xi M, Xie W. Epidemiological and clinical characteristics of older adults with burns: a 15-year retrospective analysis of 2554 cases in Wuhan Institute of Burns. BMC Geriatr. 2023 Mar 22;23(1):162.
31. Hu Y, Li D, Xu L, Hu Y, Sang Y, Zhang G, Dai H. Epidemiology and outcomes of bloodstream infections in severe burn patients: a six-year retrospective study. Antimicrob Resist Infect Control. 2021 Jun 30;10(1):98.
32. Sikwewa K, Simusika P, Mumbula M, Mwenya DM, Mandona C, Mulundu G. The occurrence of fungi from burn wound patients and antifungal susceptibility patterns: a cross-sectional study in Lusaka, Zambia. Afr Health Sci. 2023 Sep;23(3):506-513.
33. Khushalani A, Srivastava S. The epidemiology of burns in a tertiary care center of Rajasthan. Int Surg J. 2023;10:1484-9.
34. Filaj VH, Belba MK. Epidemiological trends of severe burns, 2009-2019: A study in the service of burns in Albania. Burns. 2021 Jun;47(4):930-943.

35. Pieptu V, Mihai A, Groza C, Gheorghiţă C, Cimpoieşu D, Azoicăi D. Burns in the Emergency Department: A One-Year Single Center Analysis on 355 Cases. Chirurgia (Bucur). 2020 Jul-Aug;115(4):486-492.
36. El Hayek S, Cherro M, El Harake N, Ghossoub E. Self-immolation in the Arab world: A systematic review. Burns. 2023 Jun;49(4):757-769.
37. Cao YL, Liu ZC, Chen XL. Efficacy of hydrosurgical excision combined with skin grafting in the treatment of deep partial-thickness and full-thickness burns: A two-year retrospective study. Burns. 2023 Aug;49(5):1087-1095.
38. Van Yperen DT, Van Lieshout EMM, Verhofstad MHJ, Van der Vlies CH. Epidemiology of burn rates and hospital admission from 2014 to 2018. Eur J Trauma Emerg Surg. 2022 Jun;48(3):2029-2038.
39. Abarca L, Guilabert P, Martin N, Usúa G, Barret JP, Colomina MJ. Epidemiology and mortality in patients hospitalized for burns in Catalonia, Spain. Sci Rep. 2023 Sep 1;13(1):14364.
40. Ghahghai M, Ghorbani SS, Hoseininejad S, Sheikhi A, Farhadi M, Rahbar R. Factors responsible for mortality among burns patients in Islamic Republic of Iran. East Mediterr Health J. 2023 Aug 31;29(8):650-656.
41. Bayuo J, Agbeko AE, Wong AKC, Wong FKY, Baafi EO, Baffour PK, Naw HE, Agbenorku P. Global epidemiology of geriatric burns, capacities of care, and injury outcomes: Perspectives from the World Health Organization global burn registry. Burns. 2023 Dec;49(8):1796-1807.
42. Zvizdic Z, Hukic L, Ljubovic AD, Milisic E, Jonuzi A, Vranic S. Epidemiology and early bacterial colonization of minor and moderate pediatric burns: A retrospective study from a developing country. Burns. 2023 Oct 31:S0305-4179(23)00215-2.
43. Wang C, Dou Z, Qin F, Chen H, Shen Y, Zhang GA. Epidemiology and risk prediction of patients with severe burns admitted to a burn intensive care unit in a burn center in beijing: A 5-year retrospective study. Heliyon. 2022 Dec 24;8(12):e12572.
44. Nassar JY, Al Qurashi AA, Albalawi IA, Nukaly HY, Halawani IR, Abumelha AF, Osama Al Dwehji AM, Alhartani MM, Asaad A, Alnajashi A, Khojah IM. Pediatric Burns: A Systematic Review and Meta-Analysis on Epidemiology, Gender Distribution, Risk Factors, Management, and Outcomes in Emergency Departments. Cureus. 2023 Nov 18;15(11):e49012.
45. Abul Barkat H, Abul Barkat M, Ali R, Hadi H, Kasmuri AR. Old Wine in new Bottles: Silver Sulfadiazine Nanotherapeutics for Burn Wound Management. Int J Low Extrem Wounds. 2023 May 7:15347346231166980.
46. Najm MB, Rawas-Qalaji M, Assar NH, Yahia R, Hosary RE, Ahmed IS. Optimization, characterization and in vivo evaluation of mupirocin nanocrystals for topical administration. Eur J Pharm Sci. 2022 Sep 1;176:106251.
47. Soltani R, Sajjadi Sh, Shirani K, Minaiyan M, Saghafi F. Drug Utilization Evaluation of Antibiotics in Burn Patients at a Referral Teaching Hospital. J Pharm Care 2022; 10(2): 63-68.
48. Cato LD, Al-Tarrah K, Moiemen N. Changes in Burn Wound Microbiology Profile Over 14 Years of an Adult Tertiary Burn Center. J Burn Care Res. 2023 Mar 2;44(2):293-301.
49. Chaudhary NA, Munawar MD, Khan MT, Rehan K, Sadiq A, Tameez-Ud-Din A, Bhatti HW, Rizvi ZA. Epidemiology, Bacteriological Profile, and Antibiotic Sensitivity Pattern of Burn Wounds in the Burn Unit of a Tertiary Care Hospital. Cureus. 2019 Jun 1;11(6):e4794.
50. Morin CD, Déziel E, Gauthier J, Levesque RC, Lau GW. An Organ System-Based Synopsis of Pseudomonas aeruginosa aeruginosa Virulence. Virulence. 2021 Dec;12(1):1469-1507.
51. Abesamis GMM, Cruz JJV. Bacteriologic Profile of Burn Wounds at a Tertiary Government Hospital in the Philippines-UP-PGH ATR Burn Center. J Burn Care Res. 2019 Aug 14;40(5):658-668.
52. Latifi NA, Karimi H. Correlation of occurrence of infection in burn patients. Ann Burns Fire Disasters. 2017 Sep 30;30(3):172-176.
53. Tuncal S, Altıner S, Ergüder E, Büyükkasap Ç, Kuşabbi R, Ünal Y. Comparison of open and closed burn wound dressing applications with tissue culture sampling. Ulus Travma Acil Cerrahi Derg. 2023 Jul;29(7):758-763.
54. Krir A, Dhraief S, Messadi AA, Thabet L. Profil bactériologique et résistance aux antibiotiques des bactéries isolées dans un service de réanimation des brûlés durant sept ans. Ann Burns Fire Disasters. 2019 Sep 30;32(3):197-202.
55. Aldorkee SY, Al jawed MF. Fungal Urinary Tract Infection in Burn Patients. Journal of University of Babylon, Pure and Applied Sciences. 2017;25:1693-1699.
56. Gong Y, Peng Y, Luo X, Zhang C, Shi Y, Zhang Y, Deng J, Peng Y, Luo G, Li H. Different Infection Profiles and Antimicrobial Resistance Patterns Between Burn ICU and Common Wards. Front Cell Infect Microbiol. 2021 Jun 30;11:681731.
57. Gupta M, Naik AK, Singh SK. Bacteriological profile and antimicrobial resistance patterns of burn wound infections in a tertiary care hospital. Heliyon. 2019 Dec 13;5(12):e02956.
58. Huang YZ, Lu GZ, Zhao HS, Liu LJ, Jin J, Wu YF, Wu J, Zhao FL, Liu N, Liu WM, Liu L, Zhu TJ, Chen EZ, Gu Q, Ye HW, Xi XM, Du B, Yi Y, Qiu HB. Clinical features and mortality-related factors of extensive burns among young adults: the Kunshan disaster experience. Ann Transl Med. 2020 Sep;8(17):1053.
59. Alshammari SM, Almarzouq S, Alghamdi AA, Shash H. Mortality and Survival Analysis of Burn Patients Admitted in a Critical Care Burn Unit, Saudi Arabia. Saudi J Med Med Sci. 2022 Sep-Dec;10(3):216-220.
60. Cleland H, Tracy LM, Padiglione A, Stewardson AJ. Patterns of multidrug resistant organism acquisition in an adult specialist burns service: a retrospective review. Antimicrob Resist Infect Control. 2022 Jun 13;11(1):82.
61. Dunbar C, Santorelli JE, Marshall WA, Haines LN, Box K, Lee JG, Strait E, Costantini TW, Smith AM, Doucet JJ, Berndtson AE. Cross-Border Antibiotic Resistance Patterns in Burn Patients. Surg Infect (Larchmt). 2023 May;24(4):327-3.