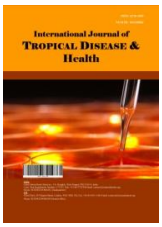

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The Microbial Profile and Antibiotic Susceptibility in Burn Wound Infection: A Hospital Based Study

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Authors' contributions

This work was carried out in collaboration between all authors. Author PDA designed the study, was involved in the treatment of the patients, literature searches, wrote the protocol, participated in analysis and wrote the first and the final drafts of the manuscript. Author GTJ performed the statistical analysis. Authors CNA, EO, SO, THG and GTJ were involved in the treatment of the patients, literature searches and analyses of the study. Authors SO and THG collected the data. All authors read and approved the final manuscript.

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ABSTRACT

Aim: To determine spectrum of bacteria infecting burn wound and its antibiotic susceptibility at Benue State University Teaching Hospital (BSUTH).
Study Design: A one year prospective study of the microbial profile in burn wound infection at BSUTH, Makurdi.
Methodology: All patients admitted from August 2018 to July 2019 with burn wound who had wound swab microscopy culture and sensitivity (MCS) after thorough cleaning of the wound were included in the study. Data collected included the Age, Sex, Occupation, Total Body Surface Area (TBSA) of burn, injuring agent, type of burn, bacteria cultured from the wound, antibiotic susceptibility, number of days of admission and outcome of treatment.

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Results: Out of the 63 patients admitted, flame was the predominant injuring agent seen in 54 (85.7%) patients. The age group 21 – 30 years was the most affected, 27 constituting 42.9%. Burn wound infection occurred in 25(39.7%) patients from whom 33 bacterial isolates were recovered. Gram negative organisms Pseudomonas species and Proteus species were the commonest bacteria isolated constituting 21.21% each. Other isolates were Staphylococcus aurous 36.36%, Escherichia coli 15.15%, Klebsiella species and Staphylococcus saprophyticus (each 3.03%,). There was multiple bacteria colonization of wounds and antibiotics resistance. There was no gender difference in the burn wound infection, P =0.7819.

Conclusion: The sensitivity pattern showed many of the bacteria to be resistant to commonly administered antibiotics but sensitivity patterns got are important for empirical antibiotics prescription when patients come with glaring sepsis and are waiting for wound swab microscopy culture and sensitivity. Studying the microbial profile with antibiotic resistance pattern in burn's wound infection should be a continuous process in all burn units/departments. This will help to formulate and modify at regular intervals, a hospital/departmental antibiotic policy according to the present microbial pattern in the respective burns unit.

Keywords: Burn; wound infection; antibiotics; susceptibility; resistance.

1. INTRODUCTION

Wound infection is a serious complication of burn as a result of the pathophysiological changes that occurs in the body of the victims. Advanced burn life support being given in burn centres across the world has revolutionalised and increased the survival of patients in the acute phase of injury; hence the problem of burn wound infection is becoming more pronounced [1].

The susceptibility to burn wound infection is a result of several factors, the most immediate and glaring being the direct inoculation of bacteria and other micro-organisms like fungi and viruses into the injured tissues due to loss of mechanical protective barrier by the skin whose integrity has been compromised by the coagulative necrosis. Other functions of the skin, tissues and organs that are lost due to thermal damage are immunological, homeostatic, metabolic thermoregulatory, neurosensory and so on which directly or indirectly predispose the patient to infections due to altered or reduced immune response.

Wound infection is an important cause of morbidity and mortality in burn patients as well as other complications that can arise in the course of treatment which include: Septicaemia, multiple organ dysfunction syndrome, psychological/psychiatric manifestation, abnormal scars with aesthetic dissatisfaction, and so on. Burn wound infection has been observed in some studies to be 22 - 37%. [2,3] Other studies have higher incidence of burn wound infection [4,5,6,7].

Pathogens implicated in burn wound infection in many studies have shown gram negative bacteria to be the commonest and many times *Pseudomonas aeruginosa* is involved [4,5,8]. *Staphylococcus aureus* tops the list in Gram positive Cocci burn wound infection [5,6]. Multiple bacterial infections in the same patient has been observed as well as the serious problem of multiple antibiotic resistance [4,5,7,8].

Prevention of burn wound infection gives best outcome with early healing and involves eschar excision and skin grafting. Institution of infection control measures by practice of aseptic technique in the handling of burn patients, barrier nursing, building up the patient's immunity and provision of adequate nutrition will help prevent burn wound infection. Detection of the bacteria and other organisms infecting the wound, their antibiotic/antimicrobial susceptibility and correct treatment will prevent further complication and mortality [3,4]. Mortality of burn due to wound infection could be as high as 25% [2]. When infection control measures are put in place burn wound infection and mortality are greatly reduced [9]. This underscores the importance of aggressive infection control, in conjunction with other treatment measures to improve survival of burn patients. The study aims at determining spectrum of bacteria infecting burn wound and its antibiotic susceptibility at BSUTH.

2. MATERIALS AND METHODS

This was a 1 year prospective study from August 2018 to July 2019. Patients admitted with burn injury in the Teaching Hospital were recruited into the study.

The BSUTH does not have a burn unit for exclusive admission of burn patients, so the patients were admitted in the intensive care unit (ICU), Surgical, Paediatric and Amenity wards. All the patients filled the consent form for recruitment (Appendix I).

Data collected included the Age, Sex, Occupation, Total Body Surface Area (TBSA) of burn, injuring agent, bacteria cultured from the wound, antibiotic susceptibility, number of days of admission and outcome of treatment. Follow up of the patients was for 3 months.

Wound swabs were used for specimen collection and inoculation into media. Specimens were taken on the 3rd and 7th day post burn after thorough wound cleaning. Inoculated discs were incubated using standard procedure. Antibiogram of each isolate was done using Kirby-Bauer disc diffusion method.

Only patients whose wound had been cultured and antibiotic susceptibility carried out were included in the study. Patients already on any antibiotic for an active bacterial infection, or on antibacterial prophylaxis, or had stopped taking antibiotic(s) for a period less than seven days prior to presentation at the facility were excluded. Also excluded were patients who refused or had no money for the wound swab microscopy culture and sensitivity.

Ethical clearance was sought from the hospital management via the Research Ethics Committee. All patients filled a consent form for recruitment (Appendix I) into the study. Data collected were entered on a proforma form (Appendix II) and analyzed by SPSS version 23.0.

3. RESULTS

63 patients participated in the study over a one year period from August 2018 to July 2019. Of these, 16 (25.4%) were females while 47 (74.6%) were males giving a female: male ratio of 1: 2.9 Table 1. The age range of the patients was One Year to 89 Years with mean age of 28.56 ± 17.0 years. The age group 21 – 30 years was the most affected, twenty seven constituting 42.9%. The predominant occupation was farming (55.6%), followed by children (15.9%) Table 1.

There was a mass casualty event in which 31 (49.21%) patients were involved.

Table 1. Sociodemographic profile of patients

Variables	Frequency	Percentage
Age group (years)		
1-10	10	15.9
11-20	5	7.9
21-30	27	42.9
31-40	12	19.0
41-50	6	9.5
51-60	1	1.6
71-80	1	1.6
91 and above	1	1.6
Sex		
Male	47	74.6
Female	16	25.4
Occupation		
Farming	35	55.6
Child	10	15.9
Student	9	14.3
Carpentry	2	3.2
Welder	2	3.2
Civil engineer	1	1.6
Driver	1	1.6
Fine Artist	1	1.6
Housewife	1	1.6
Teacher	1	1.6

Flame was the predominant injuring agent seen in 54 (85.7%) patients Table 2. The minimum total body surface area of burn was 3% and maximum 98% with mean of 33.6 ± 23.1%. The TBSA of burn and the frequency of distribution is in Table 2.

Burn wound infection occurred in 25(39.7%) patients who had isolation of one or more bacteria Table 3. Patients who had burn with TBSA 20 – 39% and had wound infection were 15 in number, 40 – 59% were 7 and the rest of the groups were 1 each.

A total of 33 bacterial isolates were recovered from the 25 burn wound samples processed during the study period. 6 (24.0%) of the 25 positive wound cultures yielded two different bacterial species each while 1 (4.0%) positive culture sample yielded three different bacterial species (*Escherichia coli*, *Staphylococcus aureus* and *Pseudomonas species*). The remaining 18 (72.0%) positive culture specimens yielded singleton growths. The predominant organisms cultured were gram negative bacteria 20 (60. 6%) Fig. 1.

A breakdown of the bacterial isolates showed that: *Staphylococcus aureus* accounted for 36.36% (n=12) of the total isolates followed by *Pseudomonas species* and *Proteus* species (each 21.21%, n=7). Other isolates were *Escherichia coli* 15.15% (n=5), *Klebsiella species* and *Staphylococcus saprophyticus* (each 3.03%, n=1) (Fig. 1).

Table 2. Type of burn and TBSA affected

Type	**Frequency**	**Percentage**
Flame	54	85.7
Scald	7	11.1
Chemical-acid	2	3.2
Total	**63**	**100.0**
Surface area affected (%)	**Frequency**	**Percentage**
<20	18	28.6
20-39	28	44.4
40=59	10	15.9
60-79	2	3.2
>80	5	7.9
Total	**63**	**100.0**

Table 3. Distribution of organisms isolated from burn wounds among patients

Organism Growth (n=63)	**Frequency**	**Percentage**
Nil, growth	38	60.3
Growth	25	39.7
Organism isolated per wound (n=24)		
Single organism		
○ *Staphylococcus aureus*	6	24.0
○ *Pseudomonas spp*	6	24.0
○ *Proteus spp*	4	16.0
○ *Escharichia coli*	2	8.0
Multiple organism		
○ *Escharichia coli and Proteus spp*	2	8.0
○ *Escharichia, Staphylococcus aureus, and Pseudomonas spp*	1	4.0
○ *Pseudomonas spp; and Staphylococcus saprophyticus*	1	4.0
○ *Staphylococcus aureus and Pseudomonas spp*	1	4.0
○ *Proteus and Staphylococcus aureus*	1	4.0
○ *Staphylococcus aureus and Klebsiella spp*	1	4.0

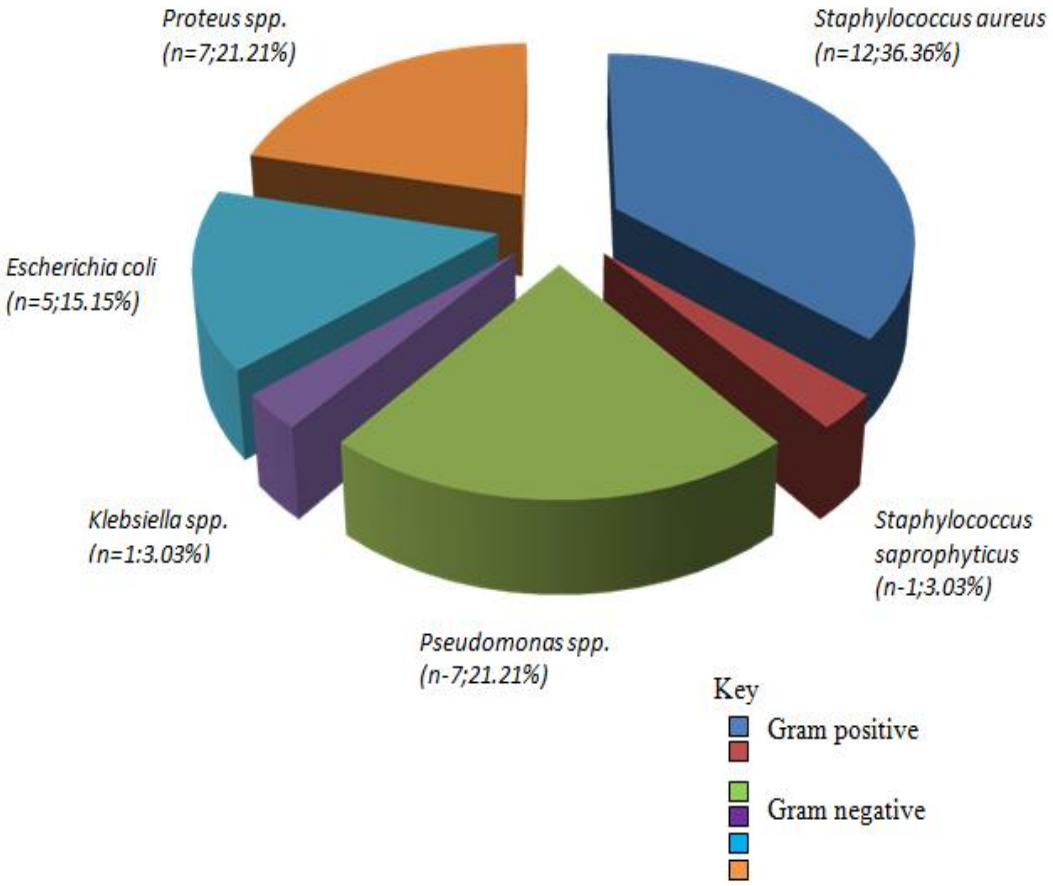

Fig. 1. Microorganisms cultured from burn wounds at Benue State University Teaching Hospital, Makurdi, Nigeria

Analysis of the antimicrobial susceptibility profiles of the isolates showed that: 100% (n=12) of the *Staphylococcus aureus* were susceptible to Cefixime and 75.3% (n=9) to Vancomycin and Ceftazidime. *S.aureus* was 66.7% (n=8) susceptible to Gentamicin, 58.3% (n=7) to Oxacillin and, Perfloxacin and 41.7% (n=5) to Ofloxacin with zero susceptibility to Erythromycin and Ceftriaxone. *Staphylococcus saprophyticus* single isolate was susceptible to Ceftazidime, Ciprofloxacin, Perfloxacin, Oxacillin and Gentamicin among others. Also all the *Pseudomonas Species* isolates (n=7) were resistant to Amoxicilline Clavulonate, Cefuroxime and Erythromycin while Cefixime, Imipenem and Meropenem had activities of 100%, 100% and 71.4% (n=5). Furthermore, Colistin Sulphate, Ciprofloxacin, Gentamicin, Imipenem, Meropenem and Cefixime were 100% active against *Klebsiella* species. *Escherichia coli* on the other hand was 20% (n=1) susceptible to Cefuroxime and Erythromycin, and 100% (n=5) susceptible to Colistin Sulphate, Meropenem, Imipenem and Cefixime. All the isolates of *Proteus species* (n=7) were 100% susceptible to Cefixime and Imipenem, and 85.7% (n=6) to Meropenem/Ofloxacin, 71.4% (n=5) to Gentamicin and 42.9% (n=3) to Perfloxacin and Ceftriaxone (Table 4).

The organisms isolated from burn wound based on gender are seen in Table 5.

Outcome of the patients showed that 19(30.2%) had split thickness skin grafting with excellent healing and all had flame as the injuring agent. 9 (14.3%) of the patients died and all of them also had flame as the injuring agent. Out of the 9, 5(55.6%) died from burn wound infection.

Table 4. Antimicrobial susceptibility patterns of microorganisms recovered from burn wounds at Benue State University Teaching Hospital Makurdi, Nigeria

Antimicrobials	Microorganisms					
	***Staph. aureus* (n=12)**	***Staph. Saprophyticus* (n=1)**	***Pseud.* spp. (n=7)**	***Klebsiella* spp. (n=1)**	***Escherichia Coli* (n=5)**	***Proteus* Spp.(n=7)**
Amoxicilline Clavulonate	7 (58.3)	0	0	0	2 (40.0)	1 (14.3)
Ceftazidime	9 (75.3)	1 (100)	4 (57.1)	0 (0.0)	4 (80)	2 (28.6)
Cefuroxime	3 (25.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (20.0)	2 (28.6)
Colistin Sulphate	4 (33.3)	0 (0.0)	3 (42.9)	1 (100)	5 (100)	1 (14.3)
Ciprofloxacin	3 (25.0)	1 (100)	2 (28.6)	1 (100)	2 (40.0)	1 (14.3)
Ofloxacin	5 (41.7)	0 (0.0)	4 (57.1)	0 (0.0)	4 (80.0)	6 (85.7)
Perfloxacin	7 (58.3)	1 (100)	3 (42.9)	0 (0.0)	2 (40.0)	3 (42.9)
Oxacillin	7 (58.3)	1 (100)	-	-	-	-
Gentamicin	8 (66.7)	1 (100)	2 (28.6)	1 (100)	4 (80.0)	5 (71.4)
Ceftriaxone	0 (0.0)	0 (0.0)	4 (57.1)	1 (100)	4 (80.0)	3 (42.9)
Vancomycin	9 (75.3)	1 (100)	-	-	-	-
Erythromycin	0 (0.0)	1 (100)	0 (0.0)	0 (0.0)	1 (20.0)	0 (0.0)
Co-trimoxazole	-	-	-	0 (0.0)	-	-
Meropenem	8 (66.7)	1 (100)	5 (71.4)	1 (100)	5 (100)	6 (85.7)
Imipenem	-	-	7 (100)	1 (100)	5 (100)	7 (100)
Cefixime	12 (100)	1 (100)	7 (100)	1 (100)	5 (100)	7 (100)

Table 5. Organism isolated per wound by sex of patients (n=25)

Growth	Male		Female		Total	
Single organism	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**
Staphyloccus aureus	4	22.2	2	28.6	6	24.0
Pseudomonas spp	4	22.2	2	28.6	6	24.0
Proteus Spp	3	16.7	1	14.3	4	16.0
Escharichia coli	2	11.1	0	0.0	2	8.0
Multiple organism						
Escharichia coli and *Proteus* Spp	1	5.6	1	14.3	2	8.0
Escharichia coli; *Staphyloccus aureus*, and *Pseudomonas* spp	1	5.6	0	0.0	1	4.0
Pseudomonas aeuriginosa; and *Staphyloccus saprophyticus*	0	0.0	1	14.3	1	4.0
Staphyloccus aureus and *Pseudomonas* Spp	1	5.6	0	0.0	1	4.0
Proteus and *Staphyloccus aureus*	1	5.6	0	0.0	1	4.0
Staphyloccus aureus and *Klebsiella* spp	1	5.6	0	0.0	1	4.0
Total	**18**	**100.0**	**7**	**100**	**25**	**100.0**

X^2 =5.572; df= 9; p-value =0.7819

Table 6. Other parameters for diagnosis of burn wound infection in patients at BSUTH

CODE	SEX	PCV %	HB g/dl	WBC	N %	L %	MXD %	ESR mm/h	BODY TEMP. °C
9	F	32.0	10.6	8.2x10³/ul	70.1	20.9	0.1	10	39.1
15	M	34.2	11.4	21.3x10³/ul	71.1	2.2	1.8	125	36.9
21	M	32.0	10.6	11.8x10³/ul	42.1	46.1	12.7	95	38.0
24	M	28.5	9.5	12.8x10³/ul	50.0	33.2	10.1	10	35.8
27	F	37.9	12.6	2.5x10³/ul	57.7	36.2	2.2	25	37.8
32	F	42.0	14.0	23.1x10³/ul	40.1	32.9	1.2	112	36.2
33	M	22.8	7.5	6.6x10³/ul	65.5	34.5	0.0	87	36.8
38	M	15.0	5.0	19x10³/ul	67.0	20.0	3.3	70	38.7
39	M	32.0	10.2	6.0x10³/ul	40.2	38.1	18.1	112	36.5
40	M	29.9	9.9	5.3x10³/ul	50.3	48.3	1.2	70	38.0
43	M	29.9	10.1	6.8x10³/ul	41.9	45.4	12.7	101	38.0
44	M	38.0	11.5	10.3x10³/ul	43.1	36.7	18.1	98	38.2
47	M	35.5	12.0	6.9x10³/ul	56.9	29.7	11.4	95	37.6
48	M	31.8	10.5	10.7x10³/ul	69.1	23.8	27.1	114	38.2
49	F	33.5	11.3	30.8x10³/ul	95.0	2.9	2.9	115	39.3
50	F	29.0	9.6	13.5x10³/ul	50.3	29.6	1.4	15	38.5
51	M	19.70	6.2	11.2x10³/ul	39.2	33.3	7.1	5	37.0
52	M	35.6	11.8	5.4x10³/ul	70.7	29.1	1.2	75	37.0
53	F	27.3	8.4	10.3x10³/ul	52.1	32.2	15.7	44	38.8
54	M	37.0	12.3	6.3x10³/ul	42.9	37.9	19.2	55	35.5
55	M	29.6	9.5	5.5x10³/ul	76.0	22.4	1.3	117	37.0
56	M	32.2	10.2	13.8x10³/ul	57.0	34.2	8.6	72	37.5
57	M	19.8	6.5	6.5x10³/ul	71.1	15.3	13.6	145	39.0
58	F	34.9	11.5	5.4x10³/ul	58.9	39.6	1.5	91	36.8
59	M	35.0	11.6	7.5x10³/ul	45.0	32.0	10.2	57	37.3

4. DISCUSSION

Our one year study demonstrated that burn wound infection occurred in 39.7% and the predominant organisms were Gram negative bacteria 60.6%. This is a high incidence of burn wound infection but consistent with other studies [6]. Some studies had higher incidence of burn wound infection [4,5,7,8,10,11]. Shrivastava and co-workers had 109 bacterial positive cultures out of 118 samples which is very high probably because in their methodology, swabs were taken before the wounds were cleaned [10]. Rezaei had 83(91.2%) bacterial positive cultures out of 91 cases which is very high also because the swabs were taken from suspected infected wounds [11], while our study showed a lower infection 39.7% because we took swabs from all wounds coming in the acute and sub-acute phase of the burn injury.

It also means that with ABLS, patients are now having adequate resuscitation and surviving in the acute phase and so burn wound infection is becoming a frequent morbidity. Of the Gram negative bacteria infecting burn wounds at BSUTH, *Pseudomonas* species and *Proteus* species were the commonest. This is also consistent with another study [3]. *Pseudomonas* species have been a common pathogen isolated from infected burn wound in other studies [4,5,8]. Multibacteria infection was observed in 24.0% of the cultures which is a trend seen in other studies [4,10,11].

Antimicrobial susceptibility profile of *pseudomonas species* in our study was poor for commonly used antibiotics like Amoxicilline Clavulonate and Erythromycin and even for a Cephalosporin, Cefuroxime. However, *pseudomonas species* were 100% responsive to Imipenem and Cefixime which are newer antibiotics but with prohibitive costs. Isolates of *proteus species* in our study showed 100% sensitivity to Cefixime and Imipenem. *Proteus species* had a good sensitivity also to Meropenem, Ofloxacin and Gentamicin. Gram positive *Staphylococcus aureus* was resistant to usual commonly used antibiotic Erythromycin and also Ceftriazone a newer and expensive Cephalosporin, but was sensitive to Cefixime, Vancomycin, Ceftazidime, Meropenem, Gentamicin, Perfloxacin, Oxacillin and Amoxicilline Clavulonate. *Staphylococcus saprophyticus* infection is not common and usually seen in Immune compromised patients as in burn injury, so was isolated only in one patient in our study and showed excellent sensitivity to virtually all the antibiotics tested. There was no gender difference in the occurrence of the burn wound infection, p-value =0.7819.

Our overall mortality was 14.3% and majority 55.6% of these patients died from burn wound infection. It is clear from our study that multiple bacteria infected patients' burn wounds and multiple antibiotic resistances occurred in them.

5. CONCLUSION

The sensitivity pattern showed many of the bacteria were resistant to commonly administered antibiotics but sensitivity patterns we have got are important for empirical antibiotics prescription when patients come with glaring sepsis and are waiting for wound swab microscopy culture and sensitivity. Studying the microbial profile with antibiotic resistance pattern in Burns' wound infection should be a continuous process in all burn units/departments. This will help to formulate, and modify at regular intervals, a hospital/departmental antibiotic policy according to the present microbial pattern in the respective burns unit.

6. LIMITATIONS OF STUDY

There was no limitation because the authors collected the data themselves and so were able to get all the information they wanted.

CONSENT

All the patients filled and signed consent form for recruitment in the study and for surgical operations.

ETHICAL APPROVAL

The Institution Management gave approval for carrying out the research.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX I

1. Consent Form for Recruitment

Dr. Priscilla Denen Akaa, Dr. Chukwukadibia Ahachi and Associate Professor Emmanuel Ojo are researchers in the Department of Surgery, Benue State University.

The aim of our research is to find out Microbial Profile and Antibiotic Susceptibility in Burn Wound Infection. Accepting to be recruited or not will not alter the management of your illness. You will be treated adequately.

I,……understand the purpose of the research and I accept to take part in it.
Name: …… Signature……..Date……
Interviewer's Name: …… Signature…… Date……..
Name of Witness……Signature…….. Date…..…….

APPENDIX II

Proforma Form.

1. Microbial Profile and Antibiotics Susceptibility in Burn Wound Infection at Benue State University Teaching Hospital

1. Serial No:…….
2. Hospital No:……..
3. Age……
4. Sex: Male ( ) Female ( )
5. Occupation……
6. Type of Burn ……
7. Total Body Surface Area of burn in %.....
8. Number of days of admission……..
9. Organism isolated from burn wound ----------

---
10. Sensitive Antibiotic ----------

---
11. Resistant Antibiotic ----------

---
12. Outcome of treatment

- Resolved (complete wound healing)
- Resolving
- Dead

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