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Microbiology of Wound Infections and its Associated Risk Factors among Patients of a Tertiary Hospital in Benin City, Nigeria

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ABSTRACT

Background: Wound infections are associated with increased morbidity and mortality. Etiologic agents of wound infections vary with geographical locations. This study was conducted to assess the prevalence of wound infections, the effect of age and gender on the prevalence as well as the etiologic agents and their susceptibility to antibacterial agents.

Methods: Wound swabs collected from 2061 patients were processed to investigate etiologic agents using standard technique. Disc susceptibility of bacterial agents was determined.

Results: The overall prevalence of wound infections was 64.8%. The prevalence of wound infections was not significantly affected by gender but was significantly affected by age ($P < 0.001$). The prevalence of wound infections was minimum among age group of <5 years old (20.0%) and maximum among the age group of 36-40 years old (77.5%). *Staphylococcus aureus* was the most prevalent etiologic agent (21.5%). β -lactams, fluoroquinolones and gentamicin were the most effective antibacterial agents.

Conclusion: The prevalence of wound infections was high and was only affected by age. *Staphylococcus aureus* was the most predominant etiologic agent and β -lactam antibiotics are recommended.

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Introduction

A wound is a breach in the skin and the exposure of subcutaneous tissue following loss of skin integrity which provides a moist, warm, and nutritive environment that is conducive for microbial colonization and proliferation^{1,2}. Wound infections have been regarded as the most common nosocomial infections and are associated with increased morbidity and mortality³⁻⁵.

Infection in a wound delays healing, causes wound breakdown, prolonged hospital stay, increased trauma care and treatment costs^{1,6}.

Bacteriological studies have also shown that wound infections is universal and that the types of bacteria vary with geographical locations, bacteria resident on the skin, clothing at the site of wound, time between wound and examination^{5,7}. The control of wound infections has become more challenging due to widespread bacterial resistance to antibiotics and due to an increasing incidence of infections caused by methicillin-resistant *Staphylococcus aureus* (MRSA) and polymicrobial flora⁵.

In developing countries, wound infections are recognized as a prominent route of bacterial infections. Many bacterial agents are known to cause wound infections^{8,9}. Isolates that have been incriminated in cases of wound infections include: *Staphylococcus aureus*, *Proteus mirabilis*, *Pseudomonas aeruginosa*, *Klebsiella aerogenes*, *Escherichia coli*, *Staphylococcus epidermidis*, *Streptococcus pyogenes* and *Streptococcus faecalis*. *Candida albicans* and *C. tropicalis* have also been implicated as etiological agents¹⁰⁻¹³.

The knowledge of the causative agents of wound infections will be therefore helpful in the selection of empiric antimicrobial therapy. Accordingly, this study was undertaken to ascertain the effect of gender and age on the prevalence of wound infections, to determine the bacterial etiology of wound infections and their susceptibilities to commonly prescribed antibiotics.

Methods

A total of 2061 wound swabs were collected from patients attending various clinics and wards in the University of Benin Teaching Hospital, Benin City, the south of Nigeria, from January 2008 to December 2010. A previous

survey of wound infections documented a prevalence of 90%¹⁴. Assuming the prevalence of wound infections to be 20% we needed a sample of 2061 at 5% significance level and 0.9 of prevalence as permissible error.

Verbal informed consent was obtained from each patient and parents/guardians in case of children prior to specimen collection. The study was approved by the Ethical Committee of the University of Benin Teaching Hospital (UBTH).

A pair of wound swab was collected from each patient and transported to the laboratory for analysis within one hour. One of the wound swabs was used to make film and stained by gram's stain. The second swab was cultured onto blood, MacConkey and Sabouraud agar, and incubated for 24 to 48 hours at 37°C. Candidiasis was diagnosed by the present of yeast-like cells as well as identification of isolates from culture. Bacteria isolates were identified using standard laboratory techniques¹⁵.

The correlation between nominal data was investigated using Chi square test. Data analysis was performed at 0.05 significance level using INSTANT® statistical software.

Table 1: The prevalence of wound infections by age (Chi square test, $P < 0.001$)

Age (year)	Male		Female		Total	
	Sample	No. of Positive Growth (%)	Sample	No. of Positive Growth (%)	Sample	No. of Positive Growth (%)
1-5	10	2 (20.0)	10	2 (20.0)	20	4 (20.0)
6-10	16	9 (56.3)	10	5 (50.0)	26	14 (53.9)
11-15	26	17 (65.4)	10	7 (70.0)	36	24 (66.7)
16-20	24	17 (70.8)	20	16 (80.0)	44	33 (75.0)
21-25	51	30 (58.8)	35	25 (71.4)	86	55 (75.9)
26-30	105	75 (71.4)	44	23 (52.3)	149	98 (65.8)
31-35	150	95 (63.3)	110	85 (77.3)	260	180 (69.2)
36-40	110	90 (81.8)	90	65 (72.2)	200	155 (77.5)
41-45	291	155 (53.3)	239	144 (60.3)	530	299 (56.4)
≥46	444	306 (68.9)	266	168 (63.2)	710	474 (66.8)
Total	1227	796 (64.9)	834	540 (64.8)	2061	1336 (64.8)

Results

The overall prevalence of wound infections was 64.8%. The prevalence of wound infections was 64.9% (796/1227) in males and 64.8% (540/834) in females ($P=0.332$). In addition, the prevalence of mixed infection was 33.3% (265/1227) in males and 33.1% (179/834) in females ($P=0.647$). The prevalence of wound infections was significantly affected by age ($P=0.000$). The minimum (20%) and maximum (77.5%) prevalence rates of wound infections were seen among the age group of 1-5 and 36-40 years old (Table 1). A total of 1781 microbial isolates were detected. *Staphylococcus aureus* was the most prevalent

etiologic agents overall and in males. *Pseudomonas aeruginosa* was the second most prevalent, but it was the most prevalent etiologic agent in females. *Streptococcus pyogenes* was the least prevalent etiologic agent overall and in both genders (Table 2).

Table 3 shows the susceptibility profiles of bacterial agents of wound infections. The beta lactams, fluoroquinolones and gentamicin were the most active antibacterial agents. Chloramphenicol, tetracycline, sulfamethoxazole-trimethoprim, cloxacillin and erythromycin were not active against any bacterial isolates.

Table 2: Distribution of wound infections by etiologic agent

Agent	Male (%)	Female (%)	Total (%)
<i>Escherichia coli</i>	102 (9.6)	63 (8.8)	165 (9.3)
<i>Klebsiella</i> spp	108 (10.2)	74 (10.3)	182 (10.2)
<i>Citrobacter</i> spp	20 (1.9)	22 (3.1)	42 (2.4)
<i>Enterobacter</i> spp	46 (4.3)	26 (2.6)	72 (4.0)
<i>Proteus</i> spp	117 (11.0)	116 (16.1)	233 (13.1)
<i>Providencia</i> spp	58 (5.5)	41 (5.7)	99 (5.6)
<i>Acinetobacter</i> spp	41 (3.9)	33 (4.6)	74 (4.2)
<i>Alcaligenes</i> spp	61 (5.7)	54 (7.5)	115 (6.5)
<i>Pseudomonas aeruginosa</i>	216 (20.4)	139 (19.3)	355 (19.9)
<i>Haemophilus influenzae</i>	20 (1.9)	9 (1.3)	29 (1.6)
<i>Staphylococcus aureus</i>	252 (23.8)	131 (18.2)	383 (21.5)
<i>Streptococcus pyogenes</i>	7 (0.7)	3 (0.4)	10 (0.6)
<i>Candida albicans</i>	13 (1.2)	9 (1.3)	22 (1.2)
Total	1061 (100.0)	720 (100.0)	1781 (100.0)

Discussion

Wound infections are associated with increased morbidity and mortality³⁻⁵. Agents of wound infections vary with geographical locations⁵. Therefore, periodic assessment of the etiologic agents and their susceptibility profiles will be useful for empirical treatment of wound.

A prevalence of 64.8% wound infections was observed in this study. This was higher than that previously reported in Indian with a prevalence of 47%⁸. However, the prevalence observed in this study is lower than that pre-

viously observed in Nigeria (90%)¹⁴. Variation in the distribution of microbial agents even between different geographical locations and regions within the same country may be responsible for this diversity.

According to our findings, no significant difference was found in the prevalence of wound infections among males and females. This result was not confirmed by previous reports where the prevalence was higher in males^{5,14}. The reason for this difference is unclear. The prevalence of mixed infections (33.2%) observed in this study was lower than

the 39.6% and 65.5% reported in previous studies^{5,14}.

The finding that age significantly affected the prevalence of wound infections did not agree with the findings of Ezebialu et al¹⁴. Torpy et al¹⁶ reported that older age is a risk factor for wound infections. This agrees with the findings of this study and may be due to decreasing trend of immune competence with age¹⁷.

Staphylococcus aureus and *Pseudomonas aeruginosa* were the first and second most prevalent

bacterial agents isolated in this study. This observation is in agreement with previous reports^{5,13,18}. However, Ezebialu et al¹⁴ reported *Pseudomonas aeruginosa* as the most prevalent agent for wound infections. They investigated wound infections among orthopaedic patients while in the present study wounds of various patients were examined. This may explain the difference between the two studies.

Table 3: Distribution of the susceptibility profiles of bacterial agents of wound infections against various antibiotics

Bacterial Agents	OFX 5mg (%)	CIP 5mg (%)	GEN 10mg (%)	AUG 30mg (%)	SXT 25mg (%)	OBE 5mg (%)	TET 10mg (%)	CXM 30mg (%)	CHL 10mg (%)	ERY 5mg (%)	CRO 30mg (%)	CAZ 30mg (%)	IMP 10mg (%)
<i>Escherichia coli</i> (n=165)	163 (98.8)	161 (97.6)	157 (95.2)	158 (95.8)	0 (0.0)	ND	0 (0.0)	158 (95.8)	0 (0.0)	ND	160 (97.0)	161 (97.6)	162 (98.2)
<i>Klebsiella</i> spp (n=182)	182 (100.0)	180 (98.9)	179 (98.4)	178 (97.8)	0 (0.0)	ND	0 (0.0)	176 (96.7)	0 (0.0)	ND	181 (99.5)	181 (99.5)	180 (98.9)
<i>Citrobacter</i> spp (n=42)	42 (100.0)	40 (100.0)	38 (90.5)	39 (92.9)	0 (0.0)	ND	0 (0.0)	38 (90.5)	0 (0.0)	ND	37 (88.1)	37 (88.1)	37 (88.1)
<i>Enterobacter</i> spp (n=72)	70 (97.2)	70 (97.2)	68 (94.4)	68 (94.4)	0 (0.0)	ND	0 (0.0)	66 (94.3)	0 (0.0)	ND	67 (93.1)	68 (94.4)	70 (97.2)
<i>Proteus</i> spp (n=233)	230 (98.7)	228 (97.6)	228 (97.6)	229 (98.3)	0 (0.0)	ND	0 (0.0)	228 (97.6)	0 (0.0)	ND	229 (98.3)	229 (98.3)	229 (98.3)
<i>Providencia</i> spp (n=99)	99 (100.0)	99 (100.0)	79 (79.8)	89 (89.9)	0 (0.0)	ND	0 (0.0)	88 (88.9)	0 (0.0)	ND	89 (89.9)	89 (89.9)	89 (89.9)
<i>Acinetobacter</i> spp (n=74)	73 (98.6)	72 (97.3)	70 (94.6)	72 (97.3)	0 (0.0)	ND	0 (0.0)	70 (94.6)	0 (0.0)	ND	71 (95.9)	72 (97.3)	71 (95.9)
<i>Alcaligenes</i> spp (n=115)	115 (100.0)	113 (98.3)	110 (95.7)	113 (98.3)	0 (0.0)	ND	0 (0.0)	107 (93.0)	0 (0.0)	ND	113 (98.3)	113 (98.3)	114 (99.1)
<i>Pseudomonas aeruginosa</i> (n=355)	353 (99.4)	301 (88.9)	350 (98.6)	350 (98.6)	0 (0.0)	ND	0 (0.0)	351 (98.9)	0 (0.0)	ND	352 (99.7)	352 (99.7)	351 (98.9)
<i>Haemophilus influenzae</i> (n=29)	27 (93.1)	25 (86.2)	20 (69.0)	22 (75.9)	0 (0.0)	0 (0.0)	0 (0.0)	20 (69.0)	0 (0.0)	ND	25 (86.2)	25 (86.2)	25 (86.2)
<i>Staphylococcus aureus</i> (n=383)	38 (100.0)	281 (73.4)	379 (99.0)	381 (99.5)	0 (0.0)	0 (0.0)	0 (0.0)	381 (99.5)	0 (0.0)	0 (0.0)	381 (99.5)	381 (99.5)	382 (99.7)
<i>Streptococcus pyogenes</i> (n=10)	8 (80.0)	8 (80.0)	6 (60.0)	8 (80.0)	0 (0.0)	0 (0.0)	0 (0.0)	6 (60.0)	0 (0.0)	0 (0.0)	6 (60.0)	6 (60.0)	7 (70.0)

OFX: Ofloxacin, CIP: Ciprofloxacin, GEN: Gentamicin, AUG: Amoxicillin-clavulanate, SXT: Sulfamethoxazole-trimethoprim, OBE: Cloxacillin, TET: Tetracycline, CXM: Cefuroxime, CHL: Chloramphenicol, ERY: Erythromycin, CRO: Ceftazidime, CAZ: Ceftriaxone, IMP: Imipenem, ND: Not done.

With the exception of erythromycin, chloramphenicol, tetracycline, cloxacillin and sulfamethoxazole-trimethoprim that showed no activity against bacterial agents, other antibiotics used in this study showed moderate to high

antibacterial activity. The high activity of the other antibacterial agents (except gentamicin) could be due to their higher cost.

The high antibacterial activity of gentamicin may be due to the fact that this antibiotic is taken parenterally and as such may not favor abuse of it in the environment. Antibacterial inactivity of erythromycin, chloramphenicol, cloxacillin, tetracycline and sulfamethoxazole-trimethoprim may be due to their long-term usage as well as low cost. Therefore, there is need for laboratory guidance before prescription of antibiotics to treat wound infections in order to preserve these effective antibacterial agents for multi-drug resistant agents. This is particularly important in our environment where prescription of antibiotics without laboratory guidance as well as over the counter sales of antibiotics without prescription are common practices that have been implicated as possible reasons for increased antimicrobial resistance observed in the country^{19,20}.

Conclusion

The prevalence of wound infections was high and was only affected by age. *Staphylococcus aureus* was the most predominant etiologic agent and β -lactam antibiotics are recommended.

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Conflict of interest statement

The authors declare no conflict of interest.

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