

# PREVALENCE OF BACTERIAL PATHOGENS IN INFECTED WOUNDS IN A TERTIARY HOSPITAL, 1995–2001: ANY CHANGE IN TREND?

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*Background:* Wound care is a very important aspect of surgical care. Knowledge of the epidemiology of bacterial pathogens associated with infected wounds is critical in formulating policies on infection control.

*Objective:* To determine the prevalence of bacterial pathogens in wounds from various units of a Nigerian tertiary hospital orthopedics and traumatology department, as well as changes over time, if any, in the prevalence rates.

*Methods:* A retrospective study was conducted using laboratory records from 1995 to 2001.

*Results:* 670 bacterial isolates from 629 patients were studied. The most common isolates were *Pseudomonas* spp.—29.9%, and *Staphylococcus aureus* (*S. aureus*)—27.5%. Others were *Klebsiella* spp.—18.5%, *Proteus* spp.—15.1%, and *Escherichia coli* (*E. coli*)—7%. The least common were *Streptococci*—2%, and *Enterococci*—0.3%. *Pseudomonas* spp. accounted for 33% of isolates in the adult wards, while *S. aureus* was 21% and *E. coli* 8%. The pattern is similar in the pediatric ward (33.9%, 23.7%, and 8.5%, respectively) and Intensive Care Unit (ICU) (40%, 6.7%, and zero, respectively). *S. aureus* was the most common isolate from the orthopedic clinics (OPD) 40%, and the A&E (35%), followed by *pseudomonas* spp.—25.4% and 19%, respectively. The odds of a wound being infected with Gram-negative bacilli among inpatients compared with outpatients is 2.44 (95% CL=1.72–3.47;  $P=0.0000003$ ) Between 1995 and 2001, the prevalence of Gram-positive bacteria decreased, while that of Gram-negative bacilli increased. The prevalence of *Pseudomonas* spp. and *S. aureus* also increased.

*Conclusion:* Wounds from patients in the orthopedics and trauma services are more frequently infected with Gram-negative bacilli than by Gram-positive bacteria. The prevalence of the former is higher in the ICU and least in the OPD. *Pseudomonas* spp. was the most common isolate. It was more common among inpatients, while *S. aureus* was more common among outpatients. The prevalence of *Pseudomonas* spp. in particular and Gram-negative bacilli in general is increasing. (*J Natl Med Assoc.* 2003;95:1189–1195.)

**Key words:** wound ♦ infection ♦ prevalence  
♦ bacteria ♦ trend ♦ orthopedics ♦ trauma

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## INTRODUCTION

Wound infection is an important cause of morbidity among surgical patients. The effects of such infections include prolonged hospitalization, thereby increasing the cost of treatment.

The management of infection is a complex and important aspect of wound care. The value of microbiology in the prevention and treatment of wound infection cannot be overemphasized, as proactive measures are made possible with a

**Table 1. Distribution of Bacterial Isolates by Specimen From Wards/Units of Orthopedic Department of a Nigerian Teaching Hospital, 1995–2001.**

Isolate	Adult Ward	Pediatric Ward	A&E	OPD	ICU	Total
<i>Staphylococcus aureus</i>						
Wound swab	65	8	21	61	1	156
Pus	-	-	-	1	-	1
Aspirate	8	6	7	6	-	27
Total	73	14	28	68	1	184
<i>Pseudomonas spp.</i>						
Wound swab	110	19	12	43	6	190
Pus	1	1	-	-	-	2
Aspirate	5	-	3	-	-	8
Total	116	20	15	43	6	200
<i>Klebsiella spp.</i>						
Wound swab	58	12	12	30	4	116
Pus	1	-	-	-	-	1
Aspirate	3	-	2	1	1	7
Total	62	12	14	31	5	124
<i>E. coli</i>						
Wound swab	22	3	4	9	-	38
Pus	-	1	-	-	-	1
Aspirate	5	1	2	-	-	8
Total	27	5	6	9	0	47
<i>Proteus spp.</i>						
Wound swab	60	7	9	14	3	93
Pus	-	-	0	0	0	0
Aspirate	6	0	2	0	0	8
Total	66	7	11	14	3	101
<i>Streptococcus pneumoniae (Strep. pneumoniae)</i>						
Wound swab	1	-	1	-	-	2
Pus	-	-	-	-	-	0
Aspirate	-	-	1	1	-	2
Total	1	0	2	1	0	4
<i>Streptococcus pyogenes (Strep. pyogenes)</i>						
Wound swab	-	-	3	2	-	5
Pus	-	-	-	-	-	0
Aspirate	1	-	-	1	-	2
Total	1	0	3	3	0	7
<i>Nonhemolytic streptococcus (Nonhemolytic strep.)</i>						
Wound swab	-	1	-	-	-	1
Pus	-	-	-	-	-	0
Aspirate	-	-	-	-	-	0
Total	0	1	0	0	0	1
<i>Enterococcus faecalis</i>						
Wound swab	2	-	-	-	-	2
Pus	-	-	-	-	-	0
Aspirate	-	-	-	-	-	0
Total	2	0	0	0	0	2

knowledge of the prevailing organisms<sup>1-4</sup>. The prevalence of different bacteria in infected wounds varies and the knowledge of prevalence in an institution cannot be extrapolated to others<sup>5</sup>. Apart from interinstitutional variation, intrainstitutional variation (differences between and within departments, respectively) also exists<sup>5-7</sup>.

The most common bacterial isolate of infected wounds are *Pseudomonas* spp., *Staphylococcus aureus*, *Klebsiella* spp., *Escherichia coli* (*E. coli*), and *Proteus* spp<sup>6</sup>. In our center, the prevalence of these bacteria may have changed over time. Differences may also exist in the prevalence in the different units of the orthopedic and trauma service, hence the need for surveillance studies of this nature. This study is important to guide the establishment of policies for empirical antibiotic treatment and control of antibiotic use.

## MATERIALS AND METHODS

A retrospective study of bacteria isolated from infected wounds of patients in the department of orthopedics and traumatology was conducted at Olabisi Onabanjo University Teaching Hospital, Sagamu, Nigeria. Hospital laboratory records were reviewed, and the records of all wound swabs, aspirates, and pus with positive cultures between January 1995 and December 2001 were selected for analysis. The years 1995 to 1997 were designated as period A, and 1998 to 2001 as period B for comparison of prevalence rates. Also patients from the adult (male and female) wards, pediatric ward, and intensive care unit (ICU) were regarded as inpatients, while those seen in the accidents and emergency (A&E) and the orthopedic clinics (OPD) were regarded as outpatients. Data were recorded on age, sex, type of specimen, year, ward or unit, and the bacterial isolate. The etiology of the wounds and antimicrobial sensitivity pattern were not subjects of this study.

## MICROBIOLOGY

All specimen sent to the microbiology laboratory were subcultured on Blood Agar (Biotec, UK) and MacConkey Agar (Biotec, UK). These were incubated in air at 37°C for 24–48 hours. The isolates were observed for colonial and Gram-stain morphology. They were identified using standard techniques<sup>8</sup>. Anaerobic cultures were not routinely done. Antibiotic sensitivity testing was done on direct sensitivity test agar (Biotec, UK) using the

disc diffusion method in accordance with the National Committee for Clinical Laboratory Standards<sup>9</sup>. *Staphylococcus aureus* (ATCC 29213) and *E. coli* (ATCC 35218) were used for quality control of all tests.

## DATA ANALYSIS

Analysis of data was done with the statistical package Epi Info version 6.04 (Centers for Disease Control, USA). Differences in proportions were tested for significance with the Yates test. A *p* value less than 0.05 was taken as significant.

## RESULTS

From 629 patients, 670 bacterial isolates were studied. These include 348 (51.9%) from the adult wards (male and female), 169 (25.3%) from the outpatient clinics, 79 (11.8%) from the A&E, 59 (8.8%) from the pediatric ward, and 15 (2.2%) from the ICU, Table 1.

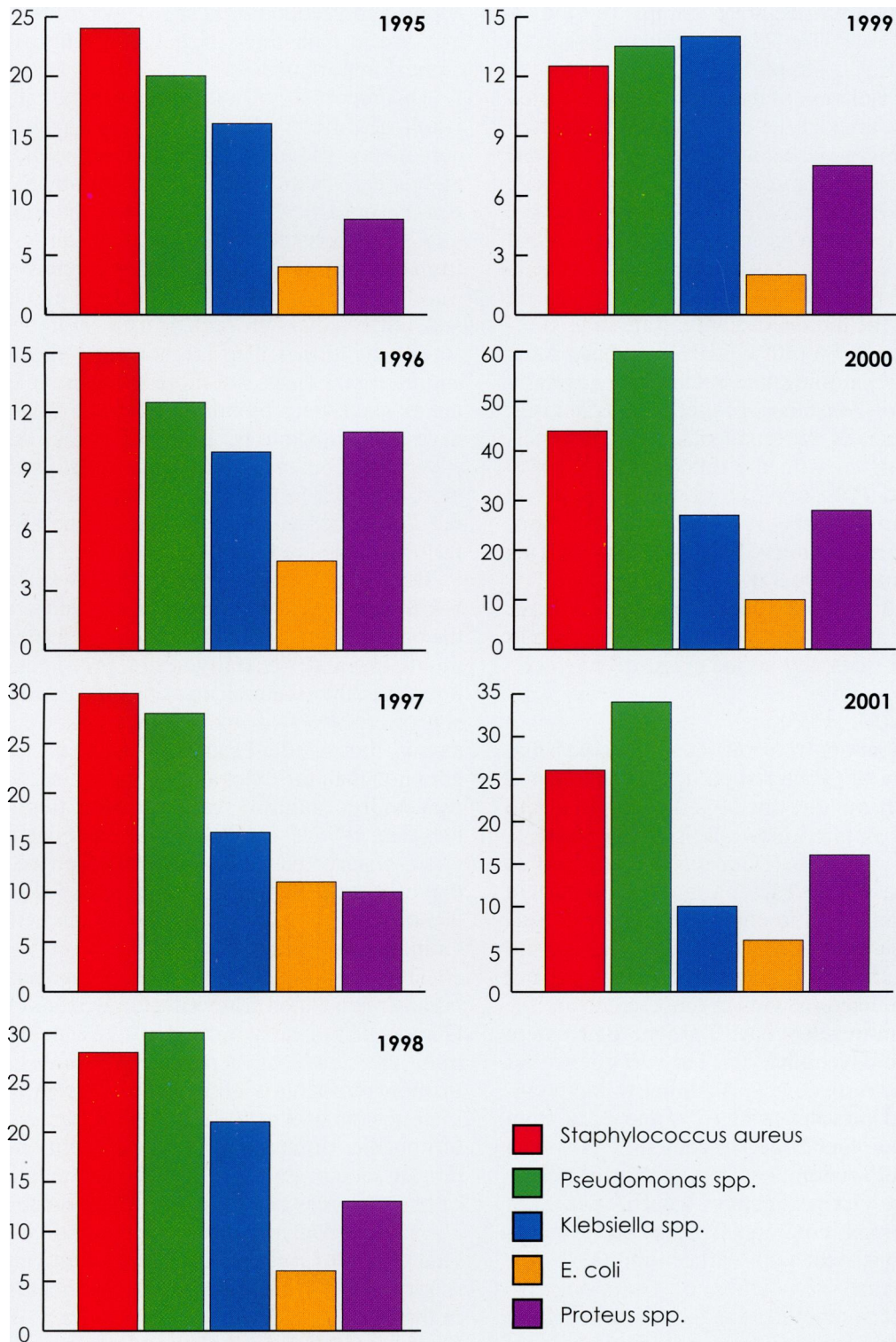
The mean age of the patients studied was 30 ± 20 years. Sixty percent (377/629) of them were males, and 40% (252/629) were females.

Six-hundred-three (90%) organisms were isolated from wound swabs, 62 (9%) from aspirates and five (1%) from pus (Table 1).

In all, 200 *Pseudomonas* spp. were isolated, representing 29.9% of all isolates. Also, there were 184 (27.5%) isolates of *Staphylococcus aureus*, 124 (18.5%) of *Klebsiella* spp., 101 (15.1%) of *Proteus* spp., and 47 (7%) of *E. coli*. There were 12 (2%) *Streptococci* and 2 (0.3%) *Enterococci*. The prevalence of Gram-positive bacteria was 30% (198/670) and that of Gram-negative bacilli was 70% (472/670) (Table 1).

Figure 1 indicates the annual distribution of isolates. In 1995, *S. aureus* was the most prevalent isolate (32%, 24/75), followed by *Pseudomonas* spp., (27%, 20/75), and *E. coli*, the least prevalent (7%, 5/75). In 1996, the prevalence of *S. aureus*, *Pseudomonas* spp., and *E. coli* followed a similar pattern as in 1995, 27% (15/56), 25% (13/56), and 9% (5/56), respectively. In 1997, the only difference in the pattern was *Proteus* spp. being the least common. From 1998 to 2001, *Pseudomonas* spp. became more prevalent than *S. aureus*. The observed difference in the prevalence of *S. aureus* (period A 71/184, period B 113/184) and *Pseudomonas* spp. (period A 60/200, period B 140/200) in the two periods under consideration, 1995–1997 and 1998–2001, is not statistically significant,  $\chi^2$

Figure 1. Annual Distribution of Bacterial Isolates, 1995–2001



2.77,  $p=0.09$ . The difference in the prevalence of Gram-positive bacteria (period A 79/198, period B 119/198) and Gram-negative bacilli (period A 156/472, period B 316/472) in the periods is also not significant,  $\chi^2$  2.58,  $p=0.1$ .

The rate of isolation of these bacteria also varied in the different units of the department, as depicted in Figure 2. From the adult wards, *Pseudomonas* spp. was the most common isolate, 33% (113/348). Others were *S. aureus* (21%, 73/348), *Proteus* spp. (19%, 66/348), *Klebsiella* spp. (18%, 62/348), and *E. coli* (8%, 27/348). This pattern of isolation is similar in the pediatric ward and the ICU. However, *S. aureus* was the most prevalent isolate in the outpatient clinics (OPD) (40%, 68/169) and the A&E (35%, 28/79). Gram-negative bacilli were generally more common than Gram-positive bacteria in all patients—especially the inpatients (75–93% versus 7–25%), compared with the outpatients (57–58% versus 42–43%). The odd of a wound being infected with Gram-negative bacilli rather than Gram-positive bacteria is 2.44 (95% CL=1.72–3.47). This difference is significant— $p=0.0000003$ .

Overall, while the prevalence of Gram-positive bacteria decreased, that of Gram-negative bacilli increased over the study period (Figure 3).

## DISCUSSION

An earlier report from our center showed that the most important bacterial pathogens in infected wounds from the orthopedic service are *Pseudomonas* spp., *Klebsiella* spp., *S. aureus*, *Proteus* spp., and *E. coli*<sup>6</sup>. Our results confirm this earlier finding. These bacteria are also important nosocomial pathogens in other Nigerian centers as well as most parts of the world<sup>10–13</sup>. *Streptococci* and *Enterococci* (2% and 0.3% in this report) are not common in infected wounds in our center.

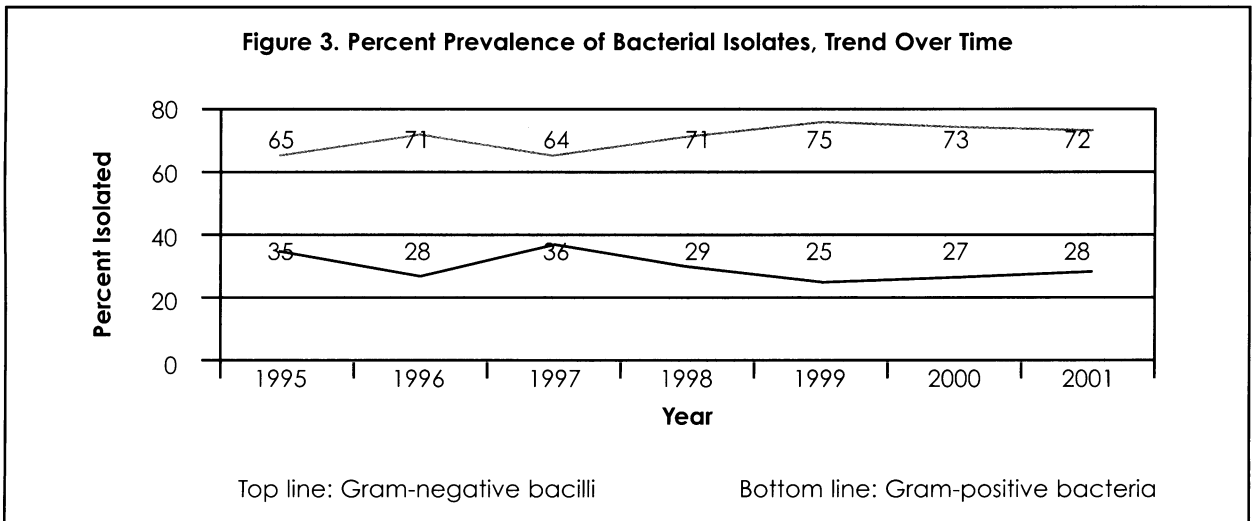
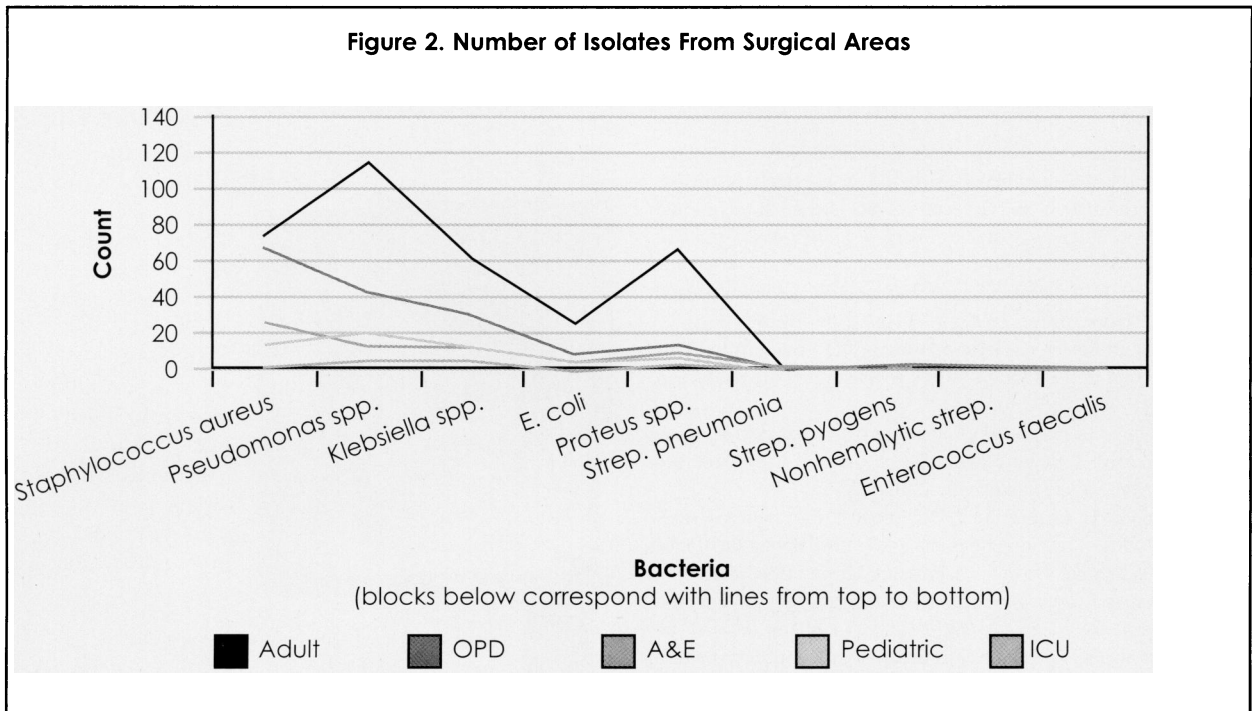
In all, Gram-negative bacilli are more prevalent than Gram-positive bacteria. The prevalence of 70% and 30%, respectively, is similar to the previously reported prevalence of 67% and 32% from our center<sup>6</sup> and other Nigerian centers<sup>14</sup>. As shown by our report, *Pseudomonas* spp. is the most common isolated Gram-negative bacilli, while *S. aureus* is the most common Gram-positive bacteria. This is consistent with earlier reports<sup>13,15</sup>. The trend in the rate of isolation of Gram-negative bacilli over the study period is that of an increase, while that of Gram-positive bacteria is one of decrease. Although these changes are not statisti-

cally significant, they are clinically important. The two most important bacterial pathogens are *S. aureus* and *Pseudomonas* spp. This report shows an increase in their rates of isolation. This also is of clinical importance.

This report shows a difference in the rate of isolation of different bacteria among inpatients and outpatients. *Pseudomonas* spp. was the most common isolate from inpatients followed by *S. aureus*. Among outpatients, *S. aureus* was the most common, an observation consistent with earlier reports from outpatient studies<sup>16</sup>. Gram-negative bacilli were more prevalent in the wounds of inpatients and outpatients but significantly more common among the former. This might be an indication that antimicrobial drugs are more extensively used for inpatients, especially broad-spectrum drugs, which have been shown to be a risk factor for Gram-negative wound infection<sup>17</sup>. Antimicrobial use may be more frequent in ICUs. It will then not be surprising that in this report, 93% of bacterial isolates from the ICU are Gram-negative.

Our results have shown that Gram-negative bacilli are more common in the infected wounds in the orthopedic service of our center—especially in the ICU—and generally more prevalent among inpatients than outpatients. Overall, *Pseudomonas* spp. were isolated more often followed by *S. aureus*, but while *Pseudomonas* spp. was more common than the latter among inpatients, *S. aureus* was more common among outpatients. Also between 1995 and 2001, the rate of isolation of Gram-positive bacteria in general decreased while that of *S. aureus* in particular increased. The rate of isolation of *Pseudomonas* spp. in particular and Gram-negative bacilli increased.

This study reflects the changing pattern of organisms isolated from infected wounds. While it is important to carry out specific research to determine the causes of these trends, it is desirable to institute protocols of antimicrobial prophylaxis and treatment as well as the duration of their use in the orthopedics and trauma services. The implementation of such protocol in addition to the knowledge of bacterial resistance pattern will reduce the overall prevalence of bacterial wound infection. Knowledge of epidemiology of bacterial infections is very important for appropriate decision-making in the treatment of bacterial infections,<sup>1,3,4</sup> especially when infection-control practitioners are involved in such decision-making<sup>2</sup>.



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