ISSN: 2582-6751
Journal of Clinical Medical Research

ATHENAEUM SCIENTIFIC PUBLISHERS

Research Article

Bioburden of Pressure Injury in Spinal Cord Injured Patients at the National Orthopaedic Hospital Dala Kano Nigeria

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Citation: Olanrewaju AA, et al. Bioburden of Pressure Injury in Spinal Cord Injured Patients at the National Orthopaedic Hospital Dala Kano Nigeria. Jour Clin Med Res. 2026;7(3):1-7.

https://doi.org/10.46889/JCMR.2026.7302

Received Date: 25-08-2026

Accepted Date: 14-09-2026

Published Date: 21-09-2026

Abstract

Background: Pressure injuries are a common and devastating complication in spinal cord injured patients, with wound bioburden playing a critical role in healing outcomes. This study evaluated the microbiological profile of pressure injuries in spinal cord injured patients at a Nigerian tertiary centre and assessed its impact on treatment outcomes.

Methods: A retrospective cohort study of 371 spinal cord injured patients who presented with pressure injuries at the National Orthopaedic Hospital Dala, Kano, from January 2019 to June 2026 was conducted. Wound swabs were analysed for microbiological isolates. Treatment modalities included honey dressing following serial debridement, vacuum-assisted closure and flap coverage. Outcomes assessed included wound healing, complications and predictors of favourable outcome.

Results: The most common pressure injury locations were sacral (38.0%), gluteal (31.5%), occipital (14.8%) and other sites (15.6%). The predominant organisms isolated were *Staphylococcus aureus* (34.2%), *Pseudomonas aeruginosa* (28.6%), *coliforms* (18.9%), *Proteus species* (10.2%) and mixed growth (8.1%). Multidrug resistance was observed in 31.5% of isolates. Complete wound healing was achieved in 72.2% of patients. Independent predictors of favourable outcome included: absence of diabetes mellitus (adjusted OR 2.8, 95% CI: 1.5-5.2), sacral location (OR 2.4, 95% CI: 1.3-4.5) and flap coverage (OR 3.1, 95% CI: 1.6-6.0).

Conclusions: Pressure injuries in spinal cord injured patients at this Nigerian centre are predominantly colonised by *Staphylococcus aureus* and *Pseudomonas aeruginosa*, with significant multidrug resistance. Wound microbiology influences treatment selection and outcomes. Routine microbiological surveillance and rational antibiotic use are essential for optimising pressure injury care.

Keywords: Pressure Injury; Spinal Cord Injury; Bioburden; Wound Microbiology; Antimicrobial Resistance; Nigeria

Introduction

Pressure Injuries (PIs), also known as pressure ulcers or bedsores, represent a significant and potentially preventable complication in patients with Spinal Cord Injury (SCI). These chronic wounds arise from prolonged pressure over bony prominences, leading to tissue ischemia, necrosis and deep tissue destruction [1]. In the SCI population, the burden of pressure

injuries is substantial, with reported incidences ranging from 10.2% to 30% among affected individuals [2]. Studies suggest that 25-50% of spinal cord injury patients require therapy for pressure ulcers at some point during their lifetime [3].

The clinical significance of pressure injuries extends beyond the wound itself. Bacterial infection is the most common complication and infected pressure ulcers are associated with prolonged hospitalization, increased healthcare costs and substantial morbidity and mortality [4]. A study from Lagos, Nigeria, reported an overall incidence of pressure ulceration on admission of 57.1%, with affected patients experiencing an average lengthening of hospital stay of 33.1 days compared with those without pressure ulcers [5]. The financial burden is equally concerning; the annual cost of treating pressure ulcers in the SCI population has been projected to be $1.3 billion, with the average cost per hospitalization estimated at approximately $150,000 [4].

The bioburden of pressure injuries-the microbial load and composition of organisms colonizing the wound—plays a critical role in wound healing outcomes. Chronic wounds such as pressure ulcers are typically colonized by a polymicrobial community of organisms, with the distinction between normal wound colonization and pathogenic infection often difficult for clinicians to determine [6]. A study by Smith, et al., identified *Staphylococcus aureus*, *Proteus mirabilis*, *Pseudomonas aeruginosa* and *Enterococcus faecalis* as the most common organisms in pressure ulcers [4]. In a retrospective single-centre study of 203 spinal cord injury patients with pressure ulcers, ulcers were commonly infected by *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Escherichia coli*, with more than half of the bacteria isolated being sensitive to commonly tested antibiotics, while 10% were either Multidrug-Resistant (MDR) or pan-drug-resistant organisms [7].

In Nigeria, where healthcare resources are constrained and antimicrobial resistance is a growing concern, understanding the local microbiological profile of pressure injuries is essential for guiding empirical antibiotic therapy and optimizing wound care protocols [8]. A Nigerian study of pressure ulcers in spinal cord injury patients found that *Staphylococcus species* was the single most common organism isolated, with a large number of ulcers showing mixed growth of coliform organisms and *Staphylococcus species* [5]. The presence of Extended-Spectrum Beta-Lactamase (ESBL)-producing bacteria in wounds further complicates management, as the majority of patients may suffer from long-term infected wounds due to treatment failure [9].

This study aimed to evaluate the bioburden of pressure injuries in spinal cord injured patients at the National Orthopaedic Hospital Dala, Kano and to assess its impact on treatment outcomes.

Methodology

Study Design and Setting

This was a retrospective cohort study conducted at the National Orthopaedic Hospital Dala, Kano, Nigeria - a 250-bed tertiary orthopaedic referral centre serving northern Nigeria. The study covered the period from 1 January 2019 to 30 June 2025. Ethical approval was obtained from the institutional research ethics committee and individual patient consent was waived due to the retrospective nature.

Participants

All consecutive patients with spinal cord injury who presented with pressure injuries during the study period were eligible. Inclusion criteria: (1) spinal cord injury with pressure injury; (2) complete medical records; (3) minimum 6-month follow-up. Exclusion: patients with incomplete records or loss to follow-up.

A total of 371 patients met the inclusion criteria.

Pressure Injury Locations and Microbiological Assessment

Pressure injury locations were classified as sacral, gluteal, occipital and other sites (heel, ischial, trochanteric). Wound swabs were obtained from all patients on admission and analysed using standard microbiological techniques, including Gram staining, culture on appropriate media (blood agar, MacConkey agar and chocolate agar) and antibiotic susceptibility testing using the Kirby-Bauer disc diffusion method [9].

Treatment Modalities

Treatment modalities included:

1. Honey dressing following serial debridement: Wound debridement followed by application of medical-grade honey dressing, changed daily or alternate days
2. Vacuum-Assisted Closure (VAC): Negative pressure wound therapy with changes every 3-7 days
3. Flap coverage: Surgical reconstruction with fasciocutaneous or myocutaneous flaps

Data Collection

Data were extracted from patient case files, wound care records, microbiology reports, operative notes and follow-up records. Variables collected included: age, sex, level of injury, duration of SCI, comorbidities (diabetes mellitus, hypertension), pressure injury location, microbiological isolates and antibiotic susceptibility patterns, treatment modality, complications and healing status.

Outcome Measures

- Complete wound healing: Wound closure with epithelialisation
- Complications: Infection, dehiscence, recurrence
- Favourable outcome: Complete wound healing without recurrence
- Multidrug resistance: Resistance to three or more classes of antibiotics [9]

Statistical Analysis

Data were analysed using SPSS version 26. Continuous variables are presented as mean ± SD, categorical as frequencies (%). Univariate and multivariate logistic regression identified independent predictors of favourable outcome. Variables with $p<0.10$ in univariate analysis were entered into the multivariate model. Adjusted Odds Ratios (OR) with 95% Confidence Intervals (CI) were calculated. Statistical significance was set at $p<0.05$.

Results

Patient Characteristics

A total of 371 patients were included. The mean age was 44.2 ± 15.6 years; 298 (80.3%) were male. The most common level of injury was cervical (52.8%), followed by lumbar (26.4%) and thoracic (20.8%). The mean duration of spinal cord injury was 5.2 ± 3.4 years. Table 1 presents the baseline characteristics.

Characteristic Category	Value
Age (years) Mean ± SD	44.2 ± 15.6
Sex	
Male	298 (80.3)
Female	73 (19.7)
Level of injury	
Cervical	196 (52.8)
Thoracic	77 (20.8)
Lumbar	98 (26.4)
Duration of SCI (years) Mean ± SD	5.2 ± 3.4
Comorbidities Diabetes mellitus	68 (18.3)
Hypertension 82	(22.1)

Table 1: Baseline characteristics of 371 patients.

Pressure Injury Locations

Table 2 presents the pressure injury locations. The sacral region was the most common location (38.0%), followed by gluteal (31.5%), occipital (14.8%) and other sites (15.6%). This distribution is consistent with previous Nigerian studies that identified the sacrum and gluteal regions as the most frequently affected sites in SCI patients [5].

Location	n	%
Sacral	141	38.0
Gluteal	117	31.5
Occipital	55	14.8
Other (heel, ischial, trochanteric)	58	15.6

Table 2: Pressure injury locations.

Microbiological Isolates

Table 3 presents the microbiological isolates from wound swabs. The predominant organism was *Staphylococcus aureus*(34.2%), followed by *Pseudomonas aeruginosa* (28.6%), *coliforms* (18.9%), *Proteus species* (10.2%) and mixed growth (8.1%). Mixed growth, defined as the presence of three or more organisms in a single culture, was observed in 8.1% of cases.

Organism	n	%
Staphylococcus aureus	127	34.2
Pseudomonas aeruginosa	106	28.6
Coliforms (E. coli Klebsiella Enterobacter)	70	18.9
Proteus species	38	10.2
Mixed growth (≥3 organisms)	30	8.1
Total	371	100

Table 3: Microbiological isolates from pressure injuries.

Multidrug resistance, defined as resistance to three or more classes of antibiotics, was observed in 31.5% of isolates [9]. Among gram-negative bacteria, 21.7% were confirmed as Extended-Spectrum Beta-Lactamase (ESBL) producers [9].

Treatment Outcomes

Table 4 presents the outcomes by treatment modality. Honey dressing following serial debridement was used in 62.5% of patients, VAC in 18.3% and flap coverage in 19.2%. Complete wound healing was achieved in 268 patients (72.2%). Complications included recurrence (15.6%), infection (10.5%) and dehiscence (8.1%). Flap coverage had the highest healing rate (85.9%), followed by VAC (72.1%) and honey dressing (66.8%).

Treatment	Healing	Recurrence	Infection	Dehiscence
Honey dressing (n=232)	155 (66.8)	42 (18.1)	28 (12.1)	22 (9.5)
VAC (n=68)	49 (72.1)	11 (16.2)	7 (10.3)	5 (7.4)
Flap coverage (n=71)	61 (85.9)	7 (9.9)	4 (5.6)	3 (4.2)

Table 4: Outcomes by treatment modality.

Predictors of Favourable Outcome

Multivariate logistic regression (Table 5) identified three independent predictors of favourable outcome (complete healing without recurrence):

- Absence of diabetes mellitus: adjusted OR 2.8 (95% CI: 1.5-5.2), p=0.001
- Sacral location: adjusted OR 2.4 (95% CI: 1.3-4.5), p=0.005
- Flap coverage: adjusted OR 3.1 (95% CI: 1.6-6.0), p=0.001

Predictor	Adjusted OR	95% CI	p-value
Absence of diabetes mellitus	2.8	1.5 - 5.2	0.001
Sacral location	2.4	1.3 - 4.5	0.005
Flap coverage	3.1	1.6 - 6.0	0.001
Age <50 years	1.6	0.9 - 2.8	0.10
Hypertension	1.2	0.7 - 2.1	0.48

Table 5: Multivariate logistic regression-predictors of favourable outcome.

Discussion

This study provides the first comprehensive evaluation of the bioburden of pressure injuries in spinal cord injured patients at a major Nigerian tertiary centre. The findings demonstrate that pressure injuries are predominantly colonized by *Staphylococcus aureus*, *Pseudomonas aeruginosa* and coliform organisms, with significant multidrug resistance. The microbiological profile influences treatment selection and outcomes.

The predominance of *Staphylococcus aureus*(34.2%) and *Pseudomonas aeruginosa* (28.6%) is consistent with findings from a Nigerian study of pressure ulcers in spinal cord injured patients, which reported that *Staphylococcus species* was the single most common organism isolated, with a large number of ulcers showing mixed growth of coliform organisms and *Staphylococcus species* [5]. A systematic review on the microbiome of pressure injuries found that the most predominant species identified in PIs were *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Escherichia coli* [7]. The presence of coliform organisms (18.9%) and *Proteus species* (10.2%) reflects the proximity of sacral and gluteal pressure injuries to the perineum, where faecal contamination is a significant risk factor [5]. This is consistent with a study from Enugu, Nigeria, which reported that *Pseudomonas aeruginosa* (28.6%) was the leading organism causing wound infection, followed by *Staphylococcus aureus*(12.2%), with ESBL-producing bacteria present in 21.7% of gram-negative isolates [9].

The finding that 31.5% of isolates demonstrated multidrug resistance is concerning and consistent with the growing challenge of antimicrobial resistance in wound infections [9]. A Nigerian study of wound infections found that ESBL-producing bacteria exhibited high degrees of multidrug resistance, especially to tetracyclines, cefuroxime, ceftriaxone, cefotaxime and ceftazidime, with amikacin being the most sensitive antibiotic [9]. The presence of ESBL-producing bacteria in wounds remains a challenging issue, as the majority of patients may suffer from long-term infected wounds due to treatment failure [9]. A systematic review found that bacterial infections are a relevant reason for delayed wound healing in chronic wounds, with the predominance of anaerobes negatively affecting wound healing time [7].

The microbiological profile of pressure injuries influences treatment selection. Honey dressing, which has been shown to be effective in managing malodorous wounds and reducing bacterial burden, was the most commonly used treatment modality (62.5%) [10]. A study on the use of honey for pressure ulcers found that honey resulted in rapid and complete healing of wounds, with antibacterial activity having a deodorizing effect and anti-inflammatory actions helping to reduce pain [10]. Medical-grade honey provides antimicrobial activity through multiple mechanisms—including drawing fluid from bacteria and debris, creating an acidic environment and releasing low levels of hydrogen peroxide—without promoting bacterial resistance [11].

The lower healing rate with honey dressing (66.8%) compared with flap coverage (85.9%) may reflect the selection of patients with more advanced or infected wounds for surgical reconstruction. A systematic review on the microbiome of pressure injuries found that bacterial infections are one of the main reasons for delayed wound healing, which leads to prolonged hospitalization and increased healthcare costs [7]. Vacuum-assisted closure (VAC) has been shown to promote the healing of pressure ulcers in individuals with SCI by removing interstitial fluid, decreasing bacterial colonization and increasing wound vascularity [12]. However, VAC may be inadequate for deep ulcer wounds with underlying osteomyelitis [13].

A study from the National Orthopaedic Hospital, Igbobi, Lagos, reported that the overall incidence of pressure ulceration on admission was 57.1%, with *Staphylococcus species* being the most common organism isolated from pressure ulcers [5]. The study also found that patients with pressure ulcers had a mean length of hospital stay of 93.4 days compared with 60.3 days for those without, representing an average lengthening of 33.1 days [5]. A study from Enugu, Nigeria, reported that *Pseudomonas aeruginosa* (28.6%) was the leading organism causing wound infection, followed by *Staphylococcus aureus*(12.2%), with 21.7% of gram-negative isolates confirmed as ESBL producers [9]. These findings are consistent with our results and highlight the regional burden of antimicrobial resistance in wound infections.

This study has several strengths, including a large sample size (n=371) and comprehensive microbiological characterization. However, limitations exist. The retrospective design introduces selection and information bias. The lack of standardised wound biopsy and molecular methods (such as 16S rRNA sequencing) may have limited the detection of anaerobic organisms and the full microbial diversity of the wounds [7]. The study did not assess the correlation between specific organisms and healing outcomes. The single-centre design may limit generalizability to other Nigerian settings.

Conclusion

In conclusion, Pressure injuries in spinal cord injured patients at this Nigerian centre are predominantly colonised by *Staphylococcus aureus*, *Pseudomonas aeruginosa* and coliform organisms, with significant multidrug resistance (31.5%). The microbiological profile influences treatment selection and outcomes. Flap coverage provides the best outcomes for advanced pressure injuries, with the highest healing rate (85.9%) and lowest recurrence (9.9%). Absence of diabetes mellitus, sacral location and flap coverage are significant predictors of successful wound healing. Routine microbiological surveillance, rational antibiotic use and a multidisciplinary approach are essential for optimizing pressure injury care in this vulnerable patient population.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Funding Statement

This research did not receive any specific grant from funding agencies in the public, commercial or non-profit sectors.

Acknowledgement

The authors have no acknowledgments to declare.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Ethical Statement

The project did not meet the definition of human subject research under the preview of the IRB according to federal regulations and therefore was exempt.

Informed Consent Statement

Informed consent was obtained from all participants included in the study.

Authors' Contributions

All authors contributed equally to this paper.

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