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Antibiotic Prescription in the Neurology Department of the Brazzaville University Hospital (Congo): Effectiveness and Factors Associated with Treatment Failure

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Abstract

Introduction: The rational use of antibiotics is critical to curb antimicrobial resistance. In neurology, healthcare-associated infections (HAIs) are frequent and require optimized prescribing. **Objective:** To assess the effectiveness of antibiotic therapy and identify factors associated with treatment failure in the neurology department of the Brazzaville University Hospital. **Methods:** This cross-sectional study (February-October 2024) included 115 adult patients with an infectious syndrome during hospitalization who received antibiotic therapy prescribed in the department. Sociodemographic, clinical, microbiological, therapeutic, and outcome data were collected prospectively. Treatment failure was defined as persistent fever or death. Variables with $p < 0.05$ in univariate analysis were entered into multivariate logistic regression. **Results:** The mean age was 61.4 ± 14.5 years; sex ratio, 1.01. Stroke was the leading diagnosis (93.9%). Main infection sites were bronchopulmonary (52.7%) and urinary (35.5%). First-line therapy was mainly empirical (94.8%), most often ceftriaxone plus metronidazole (79.1%), with 64.4% effectiveness. Effectiveness was 77.8% for second-line, and 50% for third-line regimens. Independent predictors of first-line failure included unemployment (OR = 7.97; $p < 0.001$), absence of pathogen identification (OR = 5.01; p = 0.002), out-of-pharmacy purchase (OR = 2.18; p = 0.026), non-compliant to guidelines (OR = 4.55; p = 0.030), poor treatment adherence (OR = 7.20; $p < 0.001$), and comorbidities (OR = 2.05; p = 0.030). **Conclusion:** Antibiotic effectiveness in neurology is moderate, influenced by clinical, organizational, and socioeconomic factors. Strengthening guideline compliance, expanding access to microbiological testing, and reducing self-medication are essential to improve outcomes and limiting resistance.

Keywords

Antibiotics, Healthcare-Associated Infections, Adherence, Antimicrobial Resistance, Neurology, Congo

1. Introduction

Antibiotics, discovered in the 20th century, have significantly reduced mortality from bacterial infections [1] [2]. However, their misuse and inappropriate use are major drivers of increasing bacterial resistance, representing a serious global public health concern [3] [4]. According to the U.S. Centers for Disease Control and Prevention (CDC) and the European Centre for Disease Prevention and Control (ECDC), nearly 35,000 deaths each year are attributable to bacterial resistance [3] [5]-[7]. In Africa, several studies have also reported a marked rise in resistance, reaching levels comparable to those observed in industrialized countries [8]-[10].

The proper use of antibiotics, essential for therapeutic success, depends on several factors, including pathogen identification, infection site, and patient characteristics [11]. In sub-Saharan Africa, limited access to antibiotics due to socioeconomic constraints compromises adherence and, consequently, treatment effectiveness. Rational prescribing is further hindered by challenges in pathogen identification, stemming from the high cost and prolonged turnaround time of culture results, as well as the limited range of antibiotics tested.

In hospital settings, prescribing antibiotics is a key component of infection management. In neurology, beyond infectious neurological conditions, patients are particularly vulnerable to healthcare-associated infections (HAIs) due to prolonged hospitalization, immobilization, and the use of invasive medical devices [12] [13].

Optimizing antibiotic use within a multidisciplinary framework is essential to controlling infection risk while balancing collective and individual patient interest [11] [14] [15]. In this context, several international prescribing guidelines have been issued [16]-[18]. It is therefore necessary to evaluate prescription effectiveness and identify factors associated with treatment failure to improve the management of patients hospitalized in the neurology department of the Brazzaville University Hospital.

2. Patients and Methods

2.1. Study Design and Population

A cross-sectional study with prospective data collection was conducted from February 1 to October 31, 2024, in the neurology department of the Brazzaville University Hospital. The study included all patients admitted for an infectious syndrome or who developed one during hospitalization. Eligible participants were adults (≥18 years) who received antibiotic therapy prescribed within the department and provided informed consent (or whose consent was obtained from third-party representative). Patients already on antibiotic therapy prior to admission were excluded.

2.2. Data Collection Procedures

Data were collected using a predesigned survey form, through interviews with the patient, a third-party informant, or healthcare staff, and by reviewing medical records (treatment traceability forms, prescriptions, purchase receipts, and medication packaging). Patients were assessed daily until discharge or death. Data collection was performed by the principal investigator and sixth-year medical students.

2.3. Study Variables

Patient-related variables included sociodemographic characteristics (age, sex, educational level, marital status, occupation, socioeconomic status), clinical data (diagnosis, comorbidities, portals of entry, infection sites, time to onset of fever), and paraclinical data (white blood cell count, C-reactive protein level, bacterial culture results, and antibiogram).

Antibiotic-related variables included family and drug class, type of prescription (empirical or targeted), line of treatment (first, second, third), compliance with guidelines, cost, country of manufacture, place of purchase (pharmacy or non-pharmacy), and treatment adherence.

Outcome variables included resolution or persistence of fever and hospital outcome.

2.4. Evaluation Criteria

Healthcare-associated infections (HAIs) were defined as infections occurring ≥48 h after admission or related to invasive devices such catheters or nasogastric tubes.

Effectiveness of antibiotic therapy was assessed based on clinical outcome (fever resolution) and mortality. Treatment failure was defined as persistent fever or death. Although more comprehensive definitions could include biomarkers (C-reactive protein, "CRP" leukocytosis, procalcitonin), or complications, we opted for this pragmatic and reproducible definition due to limited resources. CRP and leukocytosis were used only to support the diagnosis of infection.

Prescriptions were deemed compliant when consistent with established guidelines of the WHO AWaRE classification (2022), the IDSA/SHEA antibiotic stewardship guidelines (2016), and the French SPILF 2025 dosage recommendations [16]-[18]. Any deviation from these standards was considered non-compliant. Socioeconomic status was evaluated using a composite score based on three household indicators: daily food expenditure (1 point: <1.7 USD, 2 points: 1.7 - 3.4 USD, 3 points: 3.4 - 6.0 USD, 4 points: 6.0 - 8.6 USD, and 5 points: >8.6 USD), number of beneficiaries (1 point: ≥10, 2 points: 6 - 9, and 3 points: 2 - 5), and number of meals served per day (1 point: 1, 2 points: 2, or 3 points: ≥ 3). A total score was calculated by summing the point attributed to each indicator. Socioeconomic status was then categorized as very low (score 3 - 4), low (5 - 6), medium (7 - 8), high (9 - 10), and very high (11 - 12).

2.5. Data Analysis

Data were entered into Excel and analyzed using Epi Info version 7.2.5.0. Qualitative variables were expressed as frequencies and percentages, and quantitative variables as mean ± standard deviation or median with interquartile range, depending on the distribution. Univariate analysis used the Chi-square test for qualitative variables and the Student's *t*-test or Mann-Whitney U test for quantitative variables. Variables with a $p < 0.05$ in univariate analysis were entered into a multivariate logistic regression model. Statistical significance in the multivariate model was set at a $p < 0.05$.

2.6. Ethical Considerations

The study was approved by the Ethics Committee for Health Sciences Research (CERSSA) of the Faculty of Health Sciences, Marien Ngouabi University. Informed consent was obtained from patients or third-party representatives. Anonymity and confidentiality were ensured through coded identifiers. No conflicts of interest were declared.

3. Results

Of the 447 patients hospitalized during the study period, 332 (74.3%) were excluded because they had no infectious syndrome (n = 312) or were already receiving antibiotic therapy prior to admission (n = 20). A total of 115 patients (25.7%) met the inclusion criteria.

3.1. Sociodemographic Characteristics

The mean age was 61.4 ± 14.5 years (range: 26 - 92 years), with 58 men (50.4%) and 57 women (49.6%), yielding a *sex ratio* of 1.01. Educational level, marital status, occupation, and socioeconomic status are presented in **Table 1**.

Table 1. Educational level, marital status, occupation, and socioeconomic status.

	n	%
Level of education		
Primary	58	50.4
Secondary	49	42.6
Higher	8	7.0

Continued

Marital status		
Single	59	51.3
Married	21	18.3
Cohabiting	18	15.6
Widowed	16	13.9
Divorced	1	0.9
Occupation		
Civil servant	33	28.7
Merchant	17	14.8
Worker	14	12.2
Driver	6	5.2
Farmer	1	0.9
Unemployed	44	38.3
Socioeconomic status		
Very low	1	0.9
Low	96	83.5
High	17	14.8
Very high	1	0.9

3.2. Clinical and Microbiological Characteristics

3.2.1. Diagnosis and Comorbidities

The most frequent admission diagnoses were hemorrhagic stroke (68; 59.1%), ischemic stroke (40; 34.8%), meningitis (3; 2.6%), epilepsy (3; 2.6%), and encephalitis (1; 0.9%). Comorbidities included previous stroke (23; 20%), diabetes mellitus (14; 12.2%), HIV infection (4; 3.5%), alcohol consumption (37; 32.2%), malnutrition (5; 4.3%), and dehydration (2; 1.7%), immunosuppressant (4; 3.5%) and corticosteroid (1; 0.9%) use.

3.2.2. Infectious Syndrome

Of the 115 patients, 111 (96.5%) developed fever after more than 48 hours after admission, and 4 (3.5%) were febrile before admission.

A biological infectious syndrome was evidenced by hyperleukocytosis in 65 patients (56.5%; median WBC count: 11,000/mm^3) and elevated C-reactive protein (CRP) in 76 patients (66.1%; median CRP: 20 mg/L).

Portals of entry and infection sites (n = 110) are showed in **Table 2**.

Table 2. Portals of entry and infection sites.

	n	%
Portals of entry		
Peripheral intravenous catheter	109	94.8
Urinary catheter	98	85.2
Nasogastric tube	91	79.1
Intracranial drain	7	6.9
Pressure ulcer	6	5.2
Infectious focus		
Bronchopulmonary	58	52.7
Urinary tract	39	35.5
Skin (pressure ulcer)	6	5.5
Intrameningeal	4	3.6
Venous (phlebitis)	3	2.7

3.2.3. Microbiological Findings

Bacterial cultures were performed in 45 patients (39.1%), including urine cultures (66.7%), blood cultures (22.2%), and cerebrospinal fluid cultures (11.1%). Cultures were sterile in 33.3% of cases. Among positive cultures (66.7%), Gram-negative bacilli (GNB) accounted for 83.3% and Gram-positive cocci (GPC) for 16.7%.

3.3. Antibiotic Therapy

3.3.1. Source and Type of Antibiotics Prescribed

Antibiotics were purchased from pharmacies in 60.9% of cases. The main countries of manufacture were India (53.7%), France (14.4%), China (10.4%), Democratic Republic of Congo (9.2%), Switzerland (4.4%), Spain (3.6%), Mauritania and Tunisia (1.2% each), Pakistan (0.8%) and Russia (0.4%).

The most prescribed classes were beta-lactams (52.8%), 5-nitroimidazoles (38.8%), quinolones (6.8%), aminoglycosides (0.8%), glycopeptides (0.4%) and tetracyclines (0.4%).

First-line prescriptions were empirical in 94.8% of cases and guided by antibiogram in 5.2%. In second-line treatment (n = 36), 36.1% were empirical and 63.9% guided. The regimens used in first- and second-line treatments are detailed in Table 3.

Third-line treatment (n = 4) was empirical in 3 patients and guided in 1. The regimens used were imipenem (n = 2), levofloxacin (n = 1) and vancomycin (n = 1).

Table 3. Antibiotics prescribed as first- and second-line treatment.

	First-line therapy		Second-line therapy	
	n	%	n	%
Ceftriaxone + Metronidazole	91	79.1	7	19.4
Ceftriaxone	10	8.7	1	2.8
Ciprofloxacin	4	3.5	3	8.3
Amoxicillin + Clavulanate	2	1.7	-	-
Ofloxacin	2	1.7	3	8.3
Gentamicin	1	0.9	1	2.8
Piperacillin + Tazobactam	1	0.9	5	13.9
Cefepime	1	0.9	-	-
Cefotaxime + Metronidazole	1	0.9	-	-
Cefixime + Metronidazole	-	-	1	2.8
Levofloxacin	1	0.9	3	8.3
Doxycycline	1	0.9	-	-
Imipenem	-	-	11	30.5
Vancomycin	-	-	1	2.8

3.3.2. Cost, Adherence, and Compliance

Median treatment costs were approximatively $145 USD for first-line therapy, $169 USD for second-line, and $302 USD for third-line (equivalent to 85,000, 99,500 and 177,950 CFA francs, respectively).

Adherence rates were 80.9% for first-line therapy, 94.4% for second-line, and 75% for third-line. Compliance with prescribing guidelines was observed in 18.3% of first-line regimens, 55.6% of second-line, and 75% of third-line.

3.3.3. Treatment Effectiveness and Outcomes

Effectiveness rates were 64.4% for first-line, 77.8% for second-line, and 50% for third-line regimens. First-line failures were due to persistent fever (31.3%) or death (4.3%). Second-line failures included persistent fever (11.1%) or death (11.1%). All third-line failures resulted in death (50%).

3.4. Factors Associated with First-Line Treatment Failure

3.4.1. Univariate Analysis

Univariate and multivariate analysis of factors potentially associated with first-line treatment failure are presented in Table 4.

3.4.2. Multivariate Analysis

The final model of the multivariate analysis of factors associated with first-line treatment failure is presented in Table 5.

Table 4. Univariate analysis of sociodemographic, clinical, and antibiotic therapy-related characteristics.

		Antibiotic therapy		p
		Effective (n = 74)	Failure (n = 41)	
Age (years)*		60.5 ± 14.5	62.9 ± 14.6	0.400
Gender, n (%)	Men	37 (50.0)	21 (51.2)	0.450
	Women	37 (50.0)	20 (48.8)	
Level of education, n (%)	Primary	35 (47.3)	23 (56.1)	0.010
	Second	33 (44.6)	16 (39.0)	
	Higher	6 (8.1)	2 (4.9)	
Marital status, n (%)	Single	38 (51.3)	21 (51.2)	0.980
	Married	14 (19.2)	7 (17.1)	
	Cohabiting	11 (14.9)	7 (17.1)	
	Widowed	10 (13.5)	6 (14.6)	
	Divorced	1 (1.3)	-	
Occupation, n (%)	Employee/self-employed	46 (62.2)	7 (17.1)	<0.001
	Unemployed	28 (37.8)	34 (82.9)	
Socioeconomic status, n (%)	Very low	-	1 (2.4)	0.860
	Low	62 (83.8)	34 (83.0)	
	High	11 (14.9)	6 (14.6)	
	Very high	1 (1.3)	-	
Diagnosis, n (%)	Ischemic stroke	18 (24.3)	12 (29.4)	0.300
	Hemorrhagic stroke	31 (41.9)	34 (82.9)	
	Epilepsy	1 (1.3)	-	
	CNS infection	25 (33.8)	40 (97.7)	
Comorbidities, n (%)	Yes	25 (33.8)	21 (51.2)	0.030
Onset of fever, n (%)	After 48 hours	71 (95.9)	40 (97.6)	0.300
Leukocytes (number/mm^3)*		9997.3 ± 5604.8	10,231 ± 534.9	0.050
CRP level (mg/L)*		51.3 ± 68.0	29.4 ± 31.3	0.090
Intravenous catheter, n (%)	Yes	68 (91.9)	41 (100)	0.087
Nasogastric tube, n (%)	Yes	59 (79.7)	32 (78)	0.300
Urinary catheter, n (%)	Yes	62 (83.8)	36 (87.8)	0.400
Intracranial drain, n (%)	Yes	5 (6.7)	2 (4.9)	0.300
Pressure ulcer, n (%)	Yes	2 (2.7)	4 (9.7)	0.090
Pathogen identification, n (%)	Yes	26 (35.1)	4 (9.8)	0.020

Continued

Type of pathogen, n (%)	CGP	2 (2.7)	3 (7.3)	0.610
	BGN	9 (12.16)	16 (39.0)	
Infection sites, n (%)	Bronchopulmonary	40 (54.0)	18 (43.9)	0.800
	Urinary	24 (32.4)	15 (36.6)	
	Skin	2 (2.7)	4 (9.7)	
	Intrameningeal	2 (2.7)	2 (4.9)	
	Venous	3 (4.0)	-	
	Undetermined	3 (4.0)	2 (4.9)	
Place of purchase, n (%)	Pharmacy	50 (67.6)	20 (48.8)	0.026
Country of manufacture, n (%)	France	19 (25.7)	10 (24.4)	0.440
Type of prescription, n (%)	Empirical	70 (91.9)	40 (97.6)	0.250
Guidelines compliance, n (%)	Yes	14 (18.9)	2 (4.9)	0.040
Cost (CFA francs)*		124,899 ± 56,494	105,566 ± 55,822	0.060
Treatment adherence, n (%)	Yes	68 (91.9)	25 (61.0)	<0.001

CNS, central nervous system; CRP, C-reactive protein; GPC, Gram-positive cocci; GNB, Gram-negative bacilli; CFA, African Financial Community. *Mean ± standard deviation.

Table 5. Final model of the multivariate analysis of factors associated with treatment failure.

		Antibiotic therapy			
		Effective (n = 74)	**Failure (n = 41)**	**OR (95% CI)**	**p**
		n (%)	n (%)		
Occupation	Civil servant	46 (62.2)	7 (17.1)	1	
	Unemployed	28 (37.8)	34 (82.9)	7.97 (3.11 - 20.41)	<0.001
Pathogen identification	Yes	26 (35.1)	4 (9.8)	1	
	No	48 (64.9)	37 (90.2)	5.01 (1.60 - 15.60)	0.002
Place of purchase	Pharmacy	50 (67.5)	20 (48.8)	1	
	Outside pharmacy	24 (32.5)	21 (51.2)	2.18 (1.01 - 4.78)	0.026
Guidelines compliance	Yes	19 (25.7)	2 (4.9)	1	
	No	55 (74.3)	39 (95.1)	4.55 (1.13–21.12)	0.030
Treatment adherence	Yes	68 (91.9)	25 (60.9)	1	
	No	6 (8.1)	16 (39.1)	7.20 (2.55 - 20.63)	<0.001
Comorbidities	No	49 (66.2)	20 (48.8)	1	
	Yes	25 (33.8)	21 (51.2)	2.05 (1.77 - 4.48)	0.030

4. Discussion

4.1. Effectiveness of Antibiotic Prescribing in Neurology

In this study, nearly one-quarter of patients hospitalized in neurology department received antibiotic therapy, with only moderate effectiveness. Although the rate of antibiotic exposure was relatively high (25.7%), it remained lower than that reported in intensive care units, where it ranged from 44.1% to 71% [19] [20]. These departments generally admit patients with prolonged immobilization due to disability or sedation, as well as swallowing disorders [21]-[23]. In our cohort, 96.5% of patients had a healthcare-associated infection (HAI). As in intensive care, prolonged bed rest and the extended use of urinary or nasogastric tubes in neu-rology increase the risk of HAIs [12] [22] [24].

Most first-line prescriptions (94.8%) were empirical, reflecting delays in obtaining culture and antibiogram results, and were non-compliant with guide-lines in 81.7% of cases [25]. Despite this, effectiveness remained moderate (64.4%). The initial choice of therapy was based largely on the suspected site of infection, most often pulmonary (52.7%) or urinary (35.5%), which are among the most frequent HAIs worldwide [26] [27]. The predominance of bronchopulmo-nary infections in neurology can be explained by the high frequency of swallowing or consciousness disorders, particularly following stroke [22] [28].

The low compliance rate with guidelines (18.3% for first-line therapy) can be explained by limited availability of recommended antibiotics, the high costs of guideline-based regimens, and the absence of locally adapted protocols.

The observed first-line effectiveness may also be related to the characteristics of drugs, which were primarily pharmacy-purchased generics manufactured in India—mainly beta-lactams and 5-nitroimidazoles—with a predominance of the ceftriaxone–metronidazole combination (79.1%). Beta-lactams are favored for their moderate cost, broad spectrum, and tolerability [29] [30], but their overuse promotes the emergence of resistance [31]-[35]. Cephalosporins, a subclass of beta-lactams, are active against both Gram-positive and Gram-negative aerobes [34]. Third-generation cephalosporins such as cefotaxime and ceftriaxone have broad activity against *Enterobacterales* and certain *Streptococci* [34] [36] [37], while fourth-generation cephalosporins such as cefepime are indicated for re-sistant strains like *Pseudomonas aeruginosa* [38] [39]. The 5-nitroimidazoles, particularly metronidazole, are effective against anaerobes frequently implicated in nosocomial pulmonary infections [40] [41].

The ceftriaxone-metronidazole combination was justified in this empirical setting by its broad coverage, appropriate for polymicrobial infections, especially bronchopulmonary. This regimen is recommended for moderate to severe HAIs when rapid pathogen identification is not feasible, as it offers adequate empirical and synergistic coverage [42] [43].

In second-line therapy, the most frequent regimens were cephalosporin-metronidazole combination and imipenem, with an effectiveness of 77.8% and a median cost of $169 USD. Therapy was guided by antibiograms in 63.9% of cases and guideline-compliant in 55.6%. In third-line therapy, imipenem, levofloxacin, and vancomycin were used (50% effectiveness, median cost $302 USD), with good adherence (75%) and compliance (75%), but their high-cost limited access.

In the long term, persistent empirical prescribing and socioeconomic barriers may accelerate antimicrobial resistance in Central Africa. This highlights the urgency of adopting a One Health approach, as recommended by WHO, to coordinate human, animal, and environmental health strategies [44].

4.2. Factors Associated with Treatment Failure

Independent predictors of antibiotic failure in neurology included unemployment, comorbidities, absence of pathogen identification, purchase of antibiotics outside pharmacies, non-compliance with guidelines, and poor adherence. These findings underscore that patient-related, environmental, health system, and sociocultural factors directly influence antibiotic effectiveness.

Unemployment reduces household income and often drives patients to purchase antibiotics outside pharmacies, where drugs may be incomplete, substandard, or improperly stored. Low socioeconomic status further limits access to appropriate care and recommended treatments, favoring self-medication and reliance on unregulated sources. These practices increase the risk of poor adherence, treatment failure and fuel the emergence and spread of antimicrobial resistance [45]-[48].

In our setting, poor adherence is often related to high medication cost, frequent stockouts, limited patient education, and lack of follow-up. Such poor adherence can lead to partial pathogen eradication, relapse, and a worsened prognosis [49] [50]. Addressing these barriers requires therapeutic education sessions, active involvement of family caregivers, and continuous reinforcement by healthcare providers. Education of both patients and health professionals on the importance of strict adherence to dosage and treatment duration is essential [49] [51] [52].

Comorbidities may reduce antibiotics effectiveness due to associated immunosuppression, warranting multidisciplinary management [53] [54]. Microbiological testing felicitates targeted therapy, optimizes treatment, and limits resistance. Although few patients underwent susceptibility testing in this study, the high response rate underscores the value of rapid diagnostics—such as multiplex PCR—in avoiding unnecessary prescriptions [55]-[57].

Overall, antibiotics effectiveness depends on multiple determinants. A comprehensive, multidisciplinary, and integrated approach—combining optimized prescribing, expanded access to diagnostics, and therapeutic education—is essential to improve patient outcome and combat antimicrobial resistance [58]-[61].

4.3. Strengths and Limitations of the Study

The prospective data collection minimized recall bias and improved the accuracy of clinical and therapeutic information. Comprehensive inclusion of all eligible patients reduced selection bias and enhanced representativeness. The use of multivariate logistic regression allowed identification of independent predictors of treatment failure. Conducting the study in a department with a high prevalence of HAIs increases its relevance for designing targeted interventions.

However, the low rate of bacterial cultures (39.1%), reflecting both economic constraints and limited microbiological facilities in our setting, was a major limitation. It led to predominantly empirical prescriptions and may have biased the assessment of treatment effectiveness. Moreover, the long turnaround times for culture results further limited the early adjustment of therapy and restricted the analysis of resistance pattern. Economic constraints and the limited drug availability reduced the diversity of antibiotics assessed. Another limitation was the absence of pharmacological monitoring, such plasma concentration measurements or, pharmacokinetic/pharmacodynamic assessments, which are not available in our hospital. Finally, the pre-existing departmental policy of returning suspect medications may partially explain the relatively high observed effectiveness.

5. Conclusions

Antibiotic prescribing is a cornerstone of infection management and requires a rigorous, evidence-based approach. In the neurology department, generic beta-lactams purchased from pharmacies are frequently and empirically used. Although this practice deviates from guidelines, the current antibiotic strategy demonstrates notable effectiveness, particularly due to the synergistic combination of cephalosporins and metronidazole. Effectiveness improves when therapy is adjusted according to antibiogram results.

The main factors associated with treatment failure were unemployment, purchase of antibiotics outside licensed pharmacies, non-compliance with guidelines, poor adherence, comorbidities, and absence of pathogen identification. Optimizing antibiotic stewardship and reducing resistance require the systematic use of susceptibility testing, the de development of a regularly updated local antibiogram for the neurology department, and continuous monitoring of hospital bacterial ecology.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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