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Postoperative infections in neurosurgery from 2018 to 2023 at the Center Hospitalier Universitaire et Départemental du Borgou et de l'Alibori (CHUD-B/A) in Benin Republic

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Abstract
Introduction: Postoperative infections are the most common adverse events worldwide. They are concerning due to their high mortality rates.
Objective: To study postoperative infections in neurosurgery department.
Framework, Patients, and Method: This was a cross-sectional, descriptive, and analytical study conducted over a six-year period from January 1, 2018, to December 31, 2023. It included all cases operated on in neurosurgery at CHUD B/A.
Results: In this study, we collected data from 447 patients. The average age was 29.03±20.48 years. A male predominance was noted with a sex ratio (M/F) of 4.32. 17.23% of cases were admitted urgently to the operating room, with traumatic brain injuries (TBI) being the main reason (64.65%). Neurosurgical activity was dominated by TBI surgeries, accounting for 42.92% of hematoma evacuations. The frequency of postoperative infections was 3.80%, representing 17 cases. The most common infection was meningitis (41.17%), and an infectious syndrome was present in 64.71% of cases. In laboratory tests, 35.29% showed anemia, 76.47% had leukocytosis, and 100% had positive CRP results. The pathogens identified in the cultures (11.76%) included Staphylococcus aureus and Klebsiella pneumoniae, which were sensitive to lincosamides, C2G, or aminoglycosides. The most commonly used treatment was a combination of C3G and imidazoles (17.65%). The outcome was favorable for 12 patients, with 2 requiring reoperation. The overall mortality rate was 17.65%.
Conclusion: Postoperative infections in neurosurgery are infrequent but can be severe when they occur.

Keywords: Infection, postoperative infections, neurosurgery

Introduction

According to the WHO, healthcare-associated infections are the most common adverse medical events worldwide, with a prevalence of 5 to 15% in developed countries and a 2 to 20 times higher risk of infection in developing countries [1]. More than 1.4 million patients develop an infection at some point while being treated for a completely different condition, with an estimated average death rate of 10% [2]. A postoperative infection is defined as any infection developing within 30 days of surgery, or several months after orthopedic surgery, or several years later in the case of implanted devices [1-3]. Postoperative infections in neurosurgery are healthcare-associated infections; there are four main types: surgical site infections, urinary tract infections, respiratory tract infections, and bloodstream infections [3]. According to a study conducted in Madagascar in 2019 involving 372 patients who underwent surgery, a prevalence of 9.13% was found, with 33.41% of surgical site infections and 14.70% for the other three types of infection [4]. In Benin, although there have not been many studies on the subject in neurosurgery, prevalences of 3.9%, 5.3%, and 18.92% for surgical site infections were found in Parakou in previous studies on the surgical outcomes of lumbar canal stenosis, ventriculoperitoneal shunts, and craniocerebral wounds, respectively [5, 6].

Postoperative infections in neurosurgery are particularly concerning because they are associated with high mortality and morbidity rates. Although rare, they pose diagnostic and therapeutic problems due to the need for prolonged antibiotic therapy and, in some cases, antibiotic resistance. They increase the length of hospital stay and the risk of rehospitalization and are responsible for significant economic costs [7], with or without reoperation, thus constituting a nightmare for surgeons faced with patient dissatisfaction and sometimes litigation. A good understanding of the epidemiology, pathogenesis, and proper management of these infections, as well as their causes and morbidity factors, will not only contribute to better assessment, but also reveal new avenues of research for reducing their incidence.

The objective of this study is to describe postoperative infections in neurosurgery from 2018 to 2023 at the CHUD B/A by studying the epidemiological, clinical, paraclinical, therapeutic, and evolutionary aspects in order to better control them.

2. Population and study methods

2.1. Study setting

This study took place in the Neurosurgery Department of the Centre Hospitalier Universitaire Départemental du Borgou / Alibori (CHUB B/A), a university hospital center.

This was a descriptive and analytical cross-sectional study with retrospective data collection, running from January 2018 to December 2023. The study population consisted of all operated patients admitted to the neurosurgery department of CHUD B/A during the period.

The study inclusion criteria were

- Patients having undergone neurosurgical intervention at CHUD B/A with a complete file.
- Patients with a postoperative stay of at least 48 hours.

The study exclusion criteria were

- Patients operated on in another center and admitted to CHUD B/A;
- Infected patients discharged against medical advice before 5 days of antibiotic therapy;

Data were collected using a survey form prepared with Épi Info 7.2.2.6 software.

3. Ethical Considerations: This study was carried out as part of a PhD thesis in medicine, and the research protocol was submitted to the local ethics committee of the University of Parakou for a favourable opinion (REF:608/2024/CLERB-UP/P/SP/R/SA). This work was carried out in compliance with current ethical standards. The agreement of the authorities at various levels was obtained and the anonymity of the patients was respected.

4. Conflicts Of Interest

The authors declare that they have no conflicts of interest.

5. Results: A total of 447 files were retained for this study.

5.1. Sociodemographic characteristics: The mean age of patients operated on in the neurosurgery department between 2018 and 2023 was 29.03±20.48 years, with extremes of 1 month and 90 years. The 20-30 age group was the most represented with a proportion of 23.71%. Males accounted for 81.21%, with a sex ratio (male/female) of 4.32, as shown in figure 1.

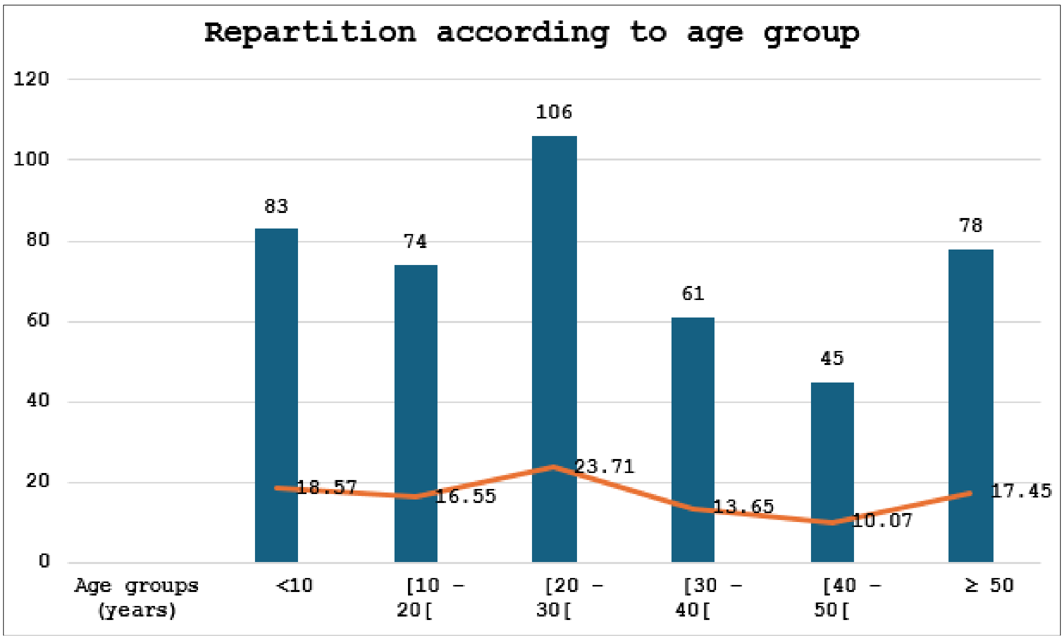

Fig 1: Distribution of patients operated on by age group (N=447)

The distribution by gender is shown in Figure 2

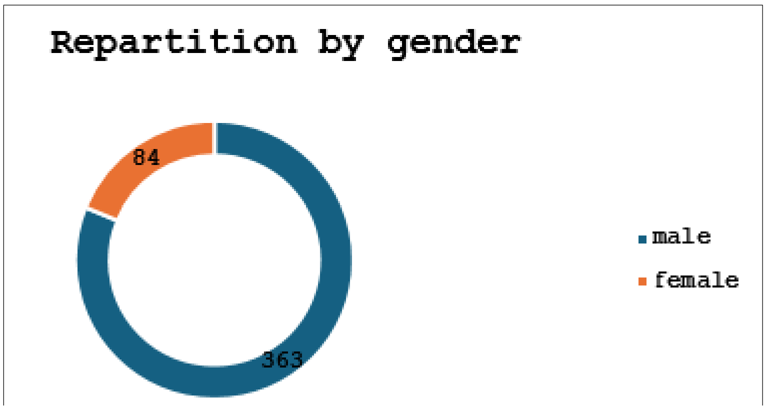

Fig 2: Distribution of patients operated on by gender (2018-2023; N=447)

The breakdown by profession showed that the majority of patients surveyed were farmers/breeders (31.54%), and only 5.59% of them had a caretaker. The detailed distribution is shown in figure 3.

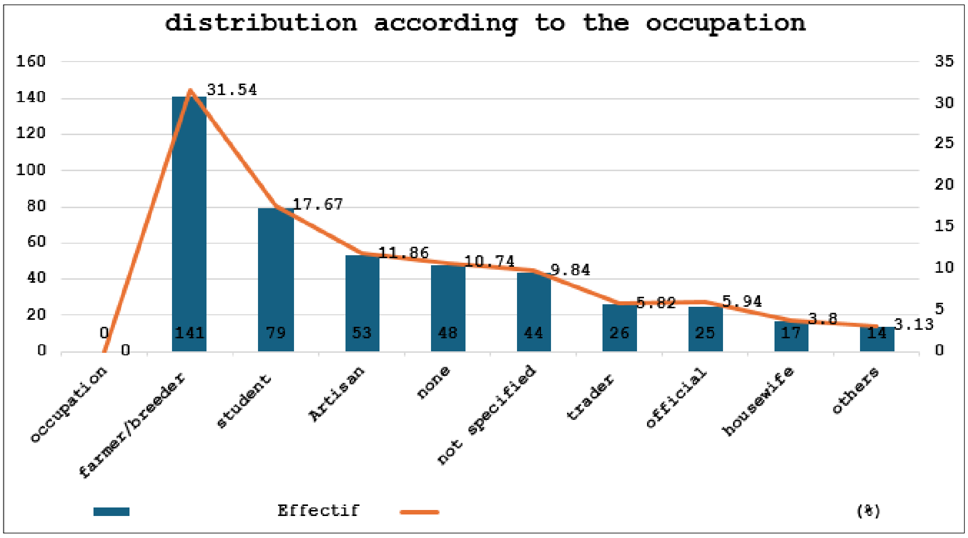

Fig 3: Distribution of patients operated on according to profession (CHUD B/A neurosurgery department, 2018-2023; N=447)

5.2. History and lifestyle of patients operated on in the neurosurgery department between 2018 and 2023

Of the 447 patients surveyed, 4.92% had a history of hypertension, and 2.91% (13) had undergone previous surgery. Of the 13, laparotomy was the surgical procedure performed in 23.08%. With regard to lifestyle, 7.16% consumed alcohol and 2.24% tobacco (see Table I).

Table 1: Distribution of operated patients according to history and lifestyle (CHUD B/A neurosurgery department, 2018-2023; N=447)

	Number	(%)
Medical History		
None	405	90,60
HTA	22	4,92
Diabetes	4	0,89
Traumatic brain injury	4	0,89
others*	13	2,91
Surgical history		
None	434	97,09
Surgical procedure	13	2,91
Operation (N=13)		
Neurosurgical	6	46,14
VP shunt	2	15,38
Tumor removal	1	7,69
decompressive Laminectomy	1	7,69
Trimming +rotation flap	1	7,69
Trepanation and drainage	1	7,69
Viscerale (Laparotomy)	5	38,46
Urology (cure herniaire)	2	15,38

Alcohol consumption		
No	415	92,84
Yes	32	7,16
Tobacco consumption		
No	437	97,76
Yes	10	2,24

*Epilepsy=1, Heart disease=1, Orbital cellulitis=1, Sickle cell disease=1, Hydrocephalus=1, Sinusitis=3, Psychiatric disorder=1, Gastric ulcer=4.

5.3. Clinical data for patients operated on in the neurosurgery department between 2018 and 2023

5.3.1. Origin and mode of admission to the OR

The majority of patients (53.69%) had been referred and 42.51% came directly from home. In terms of mode of admission to the OR, 17.23% were admitted on an emergency basis, while the remainder were placed on the weekly operating schedule (see Table II).

Table 2: Distribution of patients operated on according to their origin and mode of admission to the OR (CHUD B/A neurosurgery department, 2018-2023; N=447)

	Effectif	**(%)**
Provenance		
Hospital referral	240	53,69
House	190	42,51
Service transfer	13	2,91
Not specified	4	0,89
Mode of admission to the OR		
Programs	370	82,77
Emergency	77	17,23

5.4. Surgical indications

5.4.1. Traumatic conditions

Traumatic brain injuries accounted for 64.65% of admissions to the operating room. Of the 289 patients with TBI, 21.45% had a skull fracture and 19.03% had a cranio-cerebral wound. Spinal cord injuries accounted for 10.51% of conditions admitted to the operating room. Of the 47 patients with spinal cord injuries, 59.57% had a spinal fracture and 34.04% had a spinal dislocation, as reported in Table III.

Table 3: Distribution of traumatic conditions operated on (neurosurgery department of CHUD B/A, 2018-2023; N=447)

	Effectif	**(%)**
Cranioencephalic trauma	**289**	**64,65**
Depressed skull fracture	62	21,45
Craniocerebral wound	55	19,03
Extradural hematoma	51	17,65
Chronic subdural hematoma	34	11,76
Anterior stage fracture	26	9,00
Subacute subdural hematoma	24	8,30
Scalp wound	16	5,54
Acute subdural hematoma	15	5,19
Cutaneous cranial wound	4	1,38
Exbarrure	2	0,69
Spinal cord injury	47	10,51
Spinal fracture	28	59,57
Spinal dislocation	16	34,04
Intervertebral foreign body	1	2,13
Chronic epidural hematoma	1	2,13
Cervical parietal wound	1	2,13

5.4.2. Malformations, tumors and vascular disorders

Malformations accounted for 9.62%, with 33 cases of which 76.74% had hydrocephalus. Tumoral conditions accounted for 4.47% of cases; on the one hand, 3.79% had brain tumors, including 29.41% meningiomas; on the other hand, 0.68% had spinal tumors, 66.67% of which were extradural (Table IV).

Table 4: Distribution of malformative, tumoral and vascular conditions operated on (CHUD B/A neurosurgery department, 2018-2023; N=447)

	Effectif	**(%)**
Malformatives pathologies	43	9,62
Hydrocephalus	33	76,74
Meningocele	5	11,63
Myelomeningocele	5	11,63
Tumoral pathologies	20	4,47
Brain tumor	17	3,79
Meningioma	5	29,41
Tumor-related exophthalmos	3	17,65
Glioblastoma	2	11,76
Intracranial expansive process	2	11,76
Craniopharyngioma	1	5,88
Pineal cyst	1	5,88
Frontal sinus mucocele	1	5,88
Posterior fossa tumor	1	5,88
Scalp tumor	1	5,88
Spinal tumor	3	0,68
Extradural tumor	2	66,67
Intradural extramedullar tumor	1	33,33
Vascular disorders	8	1,79
Hemorrhagic stroke	8	100,00

5.4.3. Infectious diseases

Infectious conditions accounted for 5.15% of patients, with 4.25% of cerebral infections, the most frequent of which was cerebral empyema (63.16% of cerebral infections). Spinal cord infections accounted for 0.89% of infectious conditions, all of which were spondylodiscitis (see Table V).

Table 5: Distribution of infectious and degenerative conditions operated on (CHUD B/A neurosurgery department, 2018-2023; N=447)

	Effectif	(%)
Infectious diseases	23	5,15
Cerebral	19	4,25
Brain abscess	3	15,79
Subcutaneous suppurative collection	2	10,53
Cerebral empyema	12	63,16
Osteitis	2	10,53
Spinal	4	0,89
Spondylodiscitis	4	100,00

5.4.4. Degenerative conditions

The proportion of degenerative conditions was 3.80%, of which 35.29% were disc herniations and 64.71% were lumbar spinal stenosis.

5.4.5. Data related to surgical procedures performed on patients in the neurosurgery department

Approximately 289 TBI patients (64.65% of cases) underwent surgery at CHUD-B/A during the data collection period. The most common procedures were hematoma evacuations (42.92%). There were 47 procedures (10.51% of cases) for TVM. Osteosynthesis was performed in 59.57% of patients who had undergone TVM. Malformations accounted for 9.62% of neurosurgery operations, including 33 DVP (74.76% of cases). Tumor pathologies accounted for 4.47% of procedures, representing 3.79% of procedures on the skull and 0.68% of procedures on the spine. For the eight cases of vascular pathologies (1.79% of those operated on), EVDs and hematoma evacuations were performed in equal numbers. Of the 447 patients who underwent surgery, 27.39% (122) had a drain and 8.28% (37) had a valve (Table VI).

Table 6: Distribution of surgical procedures performed (neurosurgery department of CHUD B/A, 2018-2023; N=447)

	Effectif	(%)
Surgical procedures for traumatic brain injury	289	64,65
Hematoma evacuation	124	42,91
Lifting of depressed fracture	64	22,15
Duroplasty	55	19,03
Repair of anterior stage	26	9,00
Trimming + suture	20	6,92
Spinal surgical procedures	47	10,51
Osteosynthesis	28	59,57
Dislocation reductio	16	34,04
Trimming + suture	1	2,13
Epidural adhesiolysis	1	2,13
Foreign body removal	1	2,13
Surgical procedures for malformations	43	9,62
VP shunt	33	76,74
Meningocele surgery	5	11,63
Myelomeningocele surgery	5	11,63
Tumoral surgical procedures	20	4,47
Skull	17	3,79
Tumor removal	16	94,12
Biopsy	1	5,88
Spinal	3	0,68
Tumor removal	2	66,67
Biopsy	1	33,33
Vascular surgical procedures	8	1,79
External ventricular drainage	4	50,00
Hematoma evacuation	4	50,00

Infectious diseases accounted for 5.15% of operations, with 4.25% of procedures performed on the skull and 0.89% on the spine. Approximately 3.80% of degenerative pathologies were treated, with laminectomy being the most common procedure in 29.41% of cases (see Figure 4).

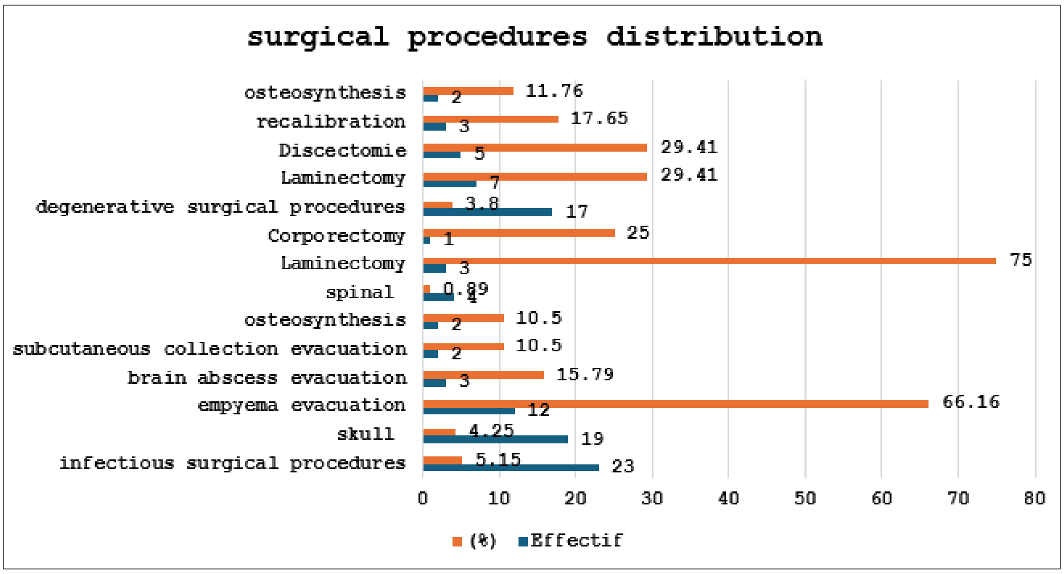

Fig 4: Distribution of surgical procedures performed (CHUD B/A neurosurgery department, 2018-2023; N=447.

5.4.6. Conditions for performing neurosurgical procedures at CHUD B/A between 2018 and 2023

The preoperative delay was between five (05) and ten (10) days for 26.40% of patients. All patients received intraoperative antibiotic prophylaxis. Upon admission to the operating room, the majority of patients (83.89%) had a Glasgow score between 13 and 15; most of them (98.21%) underwent surgery under general anesthesia. All operations were performed by a senior neurosurgeon; in 57.94% of cases, the first assistant was a DES. There were at least five (05) people involved in the operating room in 88.59% of surgical procedures. The average duration of the procedures was 122.37±81.50 minutes, with a minimum of 15 minutes and a maximum of 420 (i.e., 07 hours). The most frequent median duration was between 60 and 120 minutes (see Table VII).

Table 7: Distribution of patients according to the conditions under which surgical procedures were performed (neurosurgery department of CHUD B/A, 2018-2023; N=447)

	Effectif	**(%)**
Preoperative delay		
Same day	39	8,72
1 day	66	14,77
2 days	49	10,96
[3 - 5[days	67	14,99
[5 - 10[days	118	26,40
≥ 10 days	108	24,16
Consciousness (Glasgow Coma Scale)		
Severe ≤ 8	17	3,80
Moderate [9 -12]	55	12,30
mild [13-15]	375	83,89
Type of anesthesia		
General	439	98,21
Local/régional	8	1,79
Surgeon assistant		
DES	259	57,94
Student	145	32,44
Surgeon	22	4,92
Neurosurgeon	21	4,70
Number of practitioners		
< 5	51	11,41
≥ 5	396	88,59
Duration of procedure (minutes)		
<60	100	22,37
[60 - 120[	153	34,23
[120 -180[	112	25,06
≥180	82	18,34
Narotam classification		
Clean: class I	65	14,54
Clean-contaminated: class II	203	45,41
Contaminated: class III	19	4,25
Dirty : class IV	160	35,79

5.4.7. Postoperative data

5.4.7.1. Postoperative antibiotic therapy

In monotherapy, the most commonly used antibiotics were third-generation cephalosporins (40.98%). The most common dual therapy was a combination of third-generation cephalosporins and imidazoles (53.61%). The most commonly used triple therapy was a combination of third-generation cephalosporins, imidazoles, and aminoglycosides (54.05%). The average duration of antibiotic therapy was 8.26±5.32 days, with a minimum of two days and a maximum of 31 days. Most patients received antibiotic therapy for between 5 and 10 days (44.97%), as shown in the following table (Table VIII).

There were 27 patients (6.04%) who were non-compliant due to a lack of financial means to pay for treatment.

Table 8: Distribution of patients according to postoperative antibiotic therapy (neurosurgery department of CHUD B/A, 2018-2023; N=447)

	Effectif	(%)
Postoperative antibiotherapy		
Monotherapy	244	54,57
C3G	100	40,98
Aminopenicillin	80	32,79
C2G	64	26,23
Bitherapy	166	37,13
C3G+ imidazole	89	51,61
Aminopenicillin+ imidazole	27	16,27
C3G+ aminopenicillin	21	12,65
C2G+ aminopnicillin	14	8,43
Aminopenicillin+ aminoglycoside	9	5,42
C3G+ aminoglycoside	3	1,81
C2G+ imidazole	2	1,20
C2G+ lincosamide	1	0,60
Tritherapy	37	8,3
C3G+ imidazole+ aminoglycoside	20	54,05
Aminopenicillin+ imidazole+ aminoglycoside	4	10,81
C3G+ imidazole+ quinolone	3	8,11
C3G+ imidazole+ aminopénicilline	2	5,41
C3G+ aminopenicillin+ aminoglycoside	2	5,41
C3G+ imdazole + lincosamide	2	5,41
C2G+ imidazole+ aminoglycoside	2	5,41
Aminopnicillin+ imidazole+ lincosamide	1	2,70
C3G+ quinolone+ macrolide	1	2,70
Duration of antibiotic therapy during postoperative period (days)		
< 5	103	23,04
[5 - 10[	201	44,97
[10 - 15[	94	21,03
≥ 15	49	10,96

5.4.7.2. Clinical outcome of patients

After surgery, a good clinical outcome was observed in 89.04% of cases with recovery; 6.26% of patients died in the postoperative period. The average length of stay after surgery was 9.41 ±8.77 days, with a minimum of zero and a maximum of 80 days. The postoperative stay lasted between 5 and 10 days for 42.95% of patients. Thus, the overall length of hospitalization was 16.61 ±13.79 days, with a minimum of 3 days and a maximum of 150 days. Only 4.03% of patients had healed wounds at discharge. Patients who underwent surgery and were discharged after their stay accounted for 90.38% of cases, but others (2.24%) were discharged against medical advice (Table IX).

Table 9: Distribution of patients according to their postoperative progress (neurosurgery department of CHUD B/A, 2018-2023; N=447)

	Effectif	(%)
Outcome		
Good clinical outcome	398	89,04
Death	28	6,26
Postoperative infection	17	3,80
Transfer to intensive care	4	0,89
Length of postoperative stay (in days)		
<5	109	24,38
[5 - 10]	192	42,95
[10 - 15]	68	15,21
≥15	78	17,45
Overall length of hospital stay (in days)		
<5	27	6,04
[5 - 10]	117	26,17
[10 - 15]	99	22,15
[15 - 20]	82	18,34
≥20	122	27,29
Accidental removal of dressing		
Yes	32	7,16
No	415	92,84
Wound healed before discharge		
No	429	95,97
Yes	18	4,03
Reason for discharge		
Discharge	404	90,38
Death	32	7,16
Discharge against medical advice	11	2,46

5.5. Postoperative infections in the neurosurgery department of CHUD/B-A between 2018 and 2023

5.5.1. Prevalence of postoperative infections in the neurosurgery department of CHUD/B-A between 2018 and 2023

The prevalence of postoperative infections in the neurosurgery department of CHUD/B-A between 2018 and 2023 was 3.80%, or 17 cases (95% CI [2.39-6.01]). Postoperative infections without hardware accounted for 41.18% of postoperative infections, with 17.66% meningitis (i.e., 03 cases) and 11.76% parietal suppuration (i.e., 02 cases). Postoperative infections involving implants (valves, drains, osteosynthesis devices) accounted for 58.82% of postoperative infections, with 23.54% meningitis (4 cases) and 11.76% parietal suppuration (2 cases) as the most frequent infections (Table X).

Table 10: Distribution of postoperative infections according to the placement of surgical devices (neurosurgery department of CHUD B/A, 2018-2023; N=17)

	Postoperative infections involving implants		Postoperative infections without implants		N	%
	n	%	N	%		
Meningitis	4	23,54	3	17,66	7	41,2
Parietal suppuration	2	11,76	2	11,76	4	23,52
Sepsis	2	11,76	0	0,00	2	11,76
Ventriculitis	1	5,88	0	0,00	1	5,88
Cerebral empyema	1	5,88	0	0,00	1	5,88
Brain abscess	0	0,00	1	5,88	1	5,88
Osteiis	0	0,00	1	5,88	1	5,88
Total	10	58,82	7	41,18	17	100,00

5.5.2. Clinical data related to postoperative infections in the neurosurgery department of the CHUD/B-A between 2018 and 2023: The infection occurred on average 29.35 ±52 days after surgery, with a minimum of 3 days and a maximum of 182 days; 35.29% of postoperative infections occurred between the tenth and fifteenth day after surgery. An infectious syndrome was present in 64.71% of patients with postoperative infection, as shown in Table XI below.

Table 11: Distribution of postoperative infections according to clinical signs (CHUD B/A neurosurgery department, 2018-2023; N=17)

	Effectif	(%)
Time to infection (days)		
<5	3	17,65
[5 - 10]	4	23,53
[10 - 15]	6	35,29
≥ 15	4	23,53
Clinical signs		
Infectious syndrome	11	64,71
Parietal suppuration	4	23,53
Altered consciousness	3	17,65
Convulsions	2	11,76
Neurological deficit	2	11,76
Raised Intracranial pressure	1	5,88
Meningeal syndrome	1	5,88

5.5.3. Paraclinical data related to postoperative infections in the neurosurgery department of the CHUD/B-A between 2018 and 2023

A complete blood count (CBC) was performed on all patients. Anemia was found in 35.29% of cases, and hyperleukocytosis in 76.47% of cases. CRP was positive in all cases of postoperative infections. Pus culture performed in 11.76% of cases identified the presence of Klebsiella pneumoniae + Staphylococcus aureus (5.88%) and Staphylococcus aureus (5.88%). The bacteria were sensitive to lincosamides, C2G, or aminoglycosides. A brain scan was performed in 17.65% of cases and revealed a brain abscess (5.88%), a subcutaneous purulent collection (5.88%), and a subdural empyema (5.88%), as shown in Table XII.

Table 12: Distribution of postoperative infections according to paraclinical signs (neurosurgery department of CHUD B/A, 2018-2023; N=17)

	Effectif	(%)
Biological signs		
Complete blood count performed	17	100,00
Hyperleukocytosis	13	76,47
Anemia	6	35,29
Leukopenia	4	23,53
Positive CRP	17	100,00
CSF culture performed	0	0,00
Blood culture performed	1	5,88
No bacteria detected	1	5,88
Pus culture performed	2	11,76
Klebsiella pneumonia +Staplylococcus aureus	1	5,88
Staplylococcus aureus	1	5,88
Antibiogram (antibiotic sensitive)	2	11,76
Lincosamides	1	5,88
C2G ou Aminoglycosides	1	5,88
Imaging signs		
Brain CT scan	3	17,65
Brain abscess	1	5,88
Subcutaneous purulent collection	1	5,88
Subdural empyema	1	5,88

5.5.4. Data related to the treatment of postoperative infections: In monotherapy, the antibiotics used were third-generation cephalosporins (100%). The most common dual therapy was the combination of third-generation cephalosporins and imidazoles (33.34%). The most commonly used triple therapy was a combination of third-generation cephalosporins, imidazoles, and aminoglycosides (28.57%). The average duration of antibiotic therapy for postoperative infection was 11.76±10.24 days, with a minimum of 5 days and a maximum of 49 days. Most patients received antibiotic therapy for between 5 and 10 days (47.06%), as shown in Table XIII below. There was no non-compliance on the part of the patients.

Table 13: Distribution of patients with postoperative infection according to treatment (neurosurgery department of CHUD B/A, 2018-2023; N=17)

	Effectif	**(%)**
Antibiotics for postoperative infection		
Monotherapy (C3G)	1	5,88
Bitherapy	9	52,92
C3G+ imidazole	3	17,65
Aminopenicillin+ aminoglycoside	1	5,88
Aminopenicillin+ imidazole	1	5,88
C3G+ aminoglycoside	1	5,88
C3G+ carbapenem	1	5,88
Penicillin from group M+ imidazole	1	5,88
Aminopenicillin+ beta-lactamase inhibitor	1	5,88
Triple therapy	7	41,2
C3G+ imidazole+ aminoglycoside	2	11,76
C3G+ imidazolé+ fluoroquinolone	1	5,88
C3G+ imidazolé+ lincosamide	1	5,88
C3G+ beta-lactamase inhibitor	1	5,88
Imidazole+ fluoroquinolone+ aminoglycoside	1	5,88
C3G+ aminopenicillin+ lincosamide	1	5,88
Duration of antibiotic therapy (in days)		
[5 - 10]	8	47,06
[10 -15]	7	41,18
≥ 15	2	11,76
Other treatment		
Carbonic anhydrase inhibitor	1	5,88

5.5.5. Postoperative infection progression

After antibiotic therapy, a favorable clinical outcome was observed in 64.71% of cases; 17.65% of patients with postoperative infection died; 11.76% of them underwent repeat surgery. The two procedures performed were abscess drainage and empyema drainage, and the average duration of their postoperative antibiotic therapy was 11.5 days. One of the patients had failed to comply with treatment due to a lack of financial means to pay for care. After returning to the operating room, one of the two patients who underwent surgery died (Table XIV).

Table 14: Distribution of patients with postoperative infection according to their outcome (neurosurgery department of CHUD B/A, 2018-2023; N=17)

	Effectif	**(%)**
Outcome		
Good clinical outcome	11	64,71
Death	3	17,65
Return to operating room	2	11,76
Transfer	1	5,88
Procedure performed upon return to operating (N=02)		
Abscess drainage	1	50,00
Empyema drainage	1	50,00
Postoperative antibiotic therapy (N=02)		
C3G+ imidazole+ aminoglycoside	1	50,00
Lincosamide	1	50,00
Duration of postoperative antibiotic therapy (in days) (N=02)		
[5 -10]	1	50,00
[10 - 15]	1	50,00
Outcome of return to operating room (N=02)		
Death	1	50,00
Good clinical outcome	1	50,00

5.6. Relationship between postoperative infections and data related to surgical procedures performed in the neurosurgery department between 2018 and 2023

There was a significant association between postoperative infections and patients whose surgery lasted between 120 and 180 minutes (crude OR=0.11; p=0.0490). There was also a significant association with the presence of an intracranial or intraspinal device (crude OR=2.69; p=0.0411), as shown in Table XV.

Table 15: Univariate analysis of postoperative infections based on data related to surgical procedures performed (neurosurgery department of CHUD B/A, 2018-2023; N=447)

Postoperative infection								
	Yes		**No**		**N**	**ORbrut**	**IC à 95%**	***P***
	N	**%**	**n**	**%**				
Skull surgery								
Yes	15	4,03	357	95,97	372	1,53	0,34-6,85	0,5727
No	2	2,67	73	97,33	75	1,00		
Spinal surgery								
Yes	3	3,95	73	96,05	76	1,04	0,29-3,73	0,5747
No	14	3,77	357	96,23	371	1,00		
Intracranial or intraspinal devices								
Yes	10	6,29	149	93,71	159	2,69	1,01-7,22	**0,0411**
No	7	2,41	281	97,57	288	1,00		
Preoperative delay								
J0	2	5,13	37	94,87	39	3,56	0,31-40,60	0,3060
1 day	2	3,03	64	96,97	66	2,06	0,18-23,49	0,5589
2 days	1	2,04	48	97,96	49	1,37	0,08-22,49	0,8239
[3 - 5] days	1	1,49	66	98,51	67	1,00		
[5 - 10] days	3	2,54	115	97,46	118	1,72	0,17-16,85	0,6414
≥ 10 days	8	7,81	100	92,59	108	5,27	0,64-43,13	0,1208
Consciousness (Glasgow Coma Scale)								

Severe ≤ 8	1	5,88	16	94,12	17	1,00		
Moderate [9-12]	2	3,04	53	96,36	55	0,60	0,07-5,01	0,6882
Mild [13-15]	14	3,73	361	96,27	375	0,60	0,05-7,10	0,6544
Type of anesthesia								
General	17	3,87	422	96,13	439	ND		
Local/regional	0	0,00	8	100,00	8	1,00		

OR: Odds Ratio; ND: Not Defined; p: Uncorrected CHI2 test and Fisher's exact test, as appropriate

5.6.1.1. Relationship between postoperative infections and postoperative data for patients operated on in the neurosurgery department between 2018 and 2023

This distribution is shown in the following table (Table XVI).

Table 16: Univariate analysis of postoperative infections based on postoperative data (neurosurgery department of CHUD B/A, 2018-2023; N=447)

	Infections postopératoires							
	Yes		No		N	ORb	IC à 95%	*P*
	N	%	n	%				
Postoperative infections								
Monotherapy	8	3,28	236	96,72	244	0,77	0,27-2,16	0,6203
Dual therapy	7	4,22	159	95,78	166	1,00		
Triple therapy	2	5,41	35	94,59	37	1,30	0,25-6,52	0,7493
Duration of postoperative antibiotic therapy in hospital (days)								
< 5	3	2,91	100	97,09	103	1,00		
[5 - 10]	7	3,48	194	96,52	201	1,20	0,30-4,75	0,1846
[10 - 15]	6	6,38	88	93,62	94	2,27	0,55-9,35	0,2555
≥ 15	1	2,04	48	97,96	49	0,69	0,07-6,85	0,7549
Non-compliance with treatment								
Oui	0	0,00	27	100,00	27	ND		
Non	17	4,05	403	95,95	420	1,00		
Length of postoperative stay (in days)								
<5	1	0,92	108	99,08	109	1,00		
[5 - 10]	2	1,04	190	98,96	192	1,13	0,10-12,64	0,9181
[10 - 15]	2	2,94	66	97,06	68	3,26	0,29-36,68	0,3374
≥15	12	15,28	66	84,62	78	19,60	2,49-153,98	0,0047

ORb: crude odds ratio; ND: not defined; p: uncorrected CHI2 test and Fisher's exact test, as appropriate.

6. Discussion

6.1. Sociodemographic characteristics

The mean age of patients in the series was 29.03± 20.48 years, ranging from 1 month to 90 years. These results are similar to those of Diallo *et al.* in Mali in 2014, who reported an average age of 30.3 years [7]. They are also similar to those of Souaré *et al.* in Guinea Conakry in 2023, who found an average age of 36 years, ranging from 6 months to 70 years [8]. The most affected age group was 26-30 years old. This is similar to the 26-40 age group reported by Diop *et al.* in Senegal in 2020 [9]. They were lower than the 42.14 years reported by Doleagbenou *et al.* in Togo in 2016 [10] and the 46 years reported by Ekouele *et al.* in Congo in 2016 [11]. This difference could be explained by the fact that in our study, traumatic pathologies were mainly observed in young, active subjects. We noted a male predominance of 81.21% with a sex ratio of 4.32. This predominance has been reported by all authors [7-12]. This can be explained by the high number of traumatic pathologies in our study, which often occur in males who are required to perform risky work.

6.2. Data related to the procedure

In this study, traumatic pathology dominated neurosurgical activity (75.16%), followed by malformative pathology (9.62%). This result corroborates those of Kone *et al.* in Mauritania in 2020, who found a predominance of traumatic pathology at 55.5% [12], and Ekouele *et al.* in Congo in 2016, who found 54.84% [11]. There is a disparity with the findings of Diop *et al.* in Senegal in 2020, who reported that degenerative pathology (34.27%), followed by traumatic pathology (32.58%), dominated neurosurgical activity [9]. Similarly, Doleagbenou *et al.* in Togo in 2016 found a predominance of degenerative and traumatic pathologies, accounting for 49.48% and 25.52% of neurosurgical activity, respectively [10]. This difference could be linked to the high frequency of public traffic accidents, which are the leading cause of trauma worldwide. In our study, children under the age of 10 were the second most represented age group, and it is at this young age that malformative pathologies are most commonly detected.

6.3. Antibiotic prophylaxis

According to the French Society of Anesthesia and Intensive Care (SFAR), antibiotic prophylaxis depends on the surgical procedure. It is recommended in all cases except for external CSF shunting and skull base fractures [13]. In our study, 100% of patients received intraoperative antibiotic prophylaxis. This result is consistent with those of several authors [7, 14]. This is a surgical care practice that lasts for an average of 12 hours after surgery, depending on the type of surgery or the placement of an implant, with the aim of reducing the risk of infection.

6.4. Type of surgery

Emergency surgery accounted for 17.23% and elective surgery for 82.77% in this study. This result is similar to that reported in the literature, with elective surgery

predominating at 71.3% compared to emergency surgery (17.7%) [15, 16].
Diop *et al.* in Senegal in 2020, on the other hand, reported 68% scheduled surgery and 31.5% emergency surgery [9]. This result contrasts with that of the study in Madagascar, where 79.41% of surgery is emergency surgery compared to 20.59% scheduled surgery [4]. Kone *et al.* in Mauritania in 2020 also found 52.2% emergency surgery compared to 47.2% scheduled surgery [12].

This difference can be explained by

- The low socioeconomic status of the patients in our study. Indeed, we noted that 31.54% of patients were farmers/ranchers and only 5.59% of all our patients had health insurance. All of this contributes to the difficulties in meeting the requirements for emergency neurosurgical procedures.
- In addition, the CHUD/B does not have an operating room dedicated solely to neurosurgery. The operating room is shared by orthopedic surgery, trauma surgery, and neurosurgery. In an emergency, there may be a shortage of operating rooms and even operating room staff.

6.5. Duration of the procedure
According to the NNISS (National Nosocomial Infections Surveillance System), the risk of nosocomial infection increases with the duration of the procedure. In fact, the duration beyond which the risk of postoperative infection increases is: 4 hours for craniotomy, 2 hours for ventricular shunting, and 2 hours for other neurosurgical procedures [17, 18]. In this study, the average duration of surgery was 122.37±81.50 minutes. This result corroborates those of Diallo *et al.* in Mali in 2014, who found a duration of 149 minutes [7, 19]. This difference could be explained by the fact that tumor surgery was the most common type of surgery, and the duration of these procedures is generally longer depending on the complexity of the surgical procedure.

6.7. Frequency of postoperative infections
There were 17 cases of postoperative infectious complications out of 447 cases operated on, or 3.8% in the neurosurgery department at CHUD B/A. This rate was higher than those found by Doleagbenou *et al.* in Togo in 2016, who found a frequency of 1.6% [10], and Souaré *et al.* in Guinea Conakry in 2023, who reported a prevalence of 2.4% [8]. Furthermore, Fatigba *et al.* found similar results with 3.9% in Parakou in 2015 [6]. This frequency is lower than that found by Fotso *et al.* in South Africa in 2014, who found 4.2% of postoperative infections [15]. Similarly, Boissonneau *et al.*, in a study on postoperative complications of skull and spine surgery at the Timone University Hospital in France In fact, in our study, it was 447 patients. In contrast, Doleagbenou studied 192 patients [10] and Souaré studied 374 patients [8]. Boissonneau's study was conducted on 963 patients [2]. There is also a lack of healthcare infrastructure adapted to neurosurgery and patients have a precarious socioeconomic standard of living.

6.8. Clinical study
6.8.1. Time to infection
In our study, the postoperative infection delay was 29.35±52 days, ranging from 3 to 182 days. This delay is longer than that reported by Diallo *et al.* in Mali in 2014, who found an infection delay of less than 3 weeks [7]. Rakotozanany *et al.* in Madagascar in 2020 reported a delay of between 5 and 48 days postoperatively in Madagascar in 2021 [4]. This difference can be explained by the fact that infection can occur in a patient with osteosynthesis material several months after neurosurgery.

6.8.2. Type of infection
Meningitis was the most common postoperative infection, accounting for 41.2% of cases. These results are similar to those reported in the literature [20, 21, 22]. Similarly, Idali *et al.* in Morocco in 2003, in a study on postoperative infection after craniotomy in adults, reported that of 30 patients who had an infection (17.60%), 43.33% (13 cases) were meningitis, 30% were scalp infections, 10% were empyemas, 10% were abscesses, and 6.67% were osteitis [16]. This predominance is due to the complexity of diagnosing postoperative meningitis, as the clinical presentation is less obvious than in community-acquired meningitis. According to Belarbi [23], it is generally characterized by headaches and an infectious syndrome. Meningeal signs, on the other hand, are uncommon. When these signs are present, inflammatory tests and a lumbar puncture are performed. While awaiting the bacteriological results, probabilistic antibiotic therapy should be initiated.

6.8.3. Bacteriological results
In our series, the germs at the surgical site were dominated by Staphylococcus aureus (8.82%), followed by Klebsiella pneumoniae (5.88%). These results are similar to those of Diallo *et al.* in Mali in 2014, who found a predominance of Staphylococcus aureus at 56.25% [7]. Fotso *et al.* found 19.7% Staphylococcus aureus followed by 12.7% Klebsiella pneumoniae [15], as did Dashti *et al.* in Arizona in 2008, who reported a predominance of Staphylococcus aureus [19]. These results corroborate those in the literature, as these are skin bacteria.

6.8.4. Antibiotic therapy for postoperative infection
In our study, the combination of third-generation cephalosporins and imidazoles was the most commonly used (17.65%) for the treatment of postoperative infections. These results are consistent with the microbial flora identified in other studies [2, 6]. This is in fact broad-spectrum antibiotic therapy while awaiting the antibiogram.

6.8.4.1. Duration of antibiotic therapy
In this series, the average duration of treatment was 11.76±10.24 days, with extremes of 5 and 49 days. These results are similar to those of Souaré *et al.* in Guinea Conakry in 2023, who found an average treatment duration of 12 days [8]. Rakotoazanany *et al.* in Madagascar in 2020 reported an average duration of 13 days, with extremes of 7 and 30 days in our study [4]. The duration of antibiotic therapy can be long, due to the severity of these postoperative infections, which require adequate antibiotic coverage until clinical signs, but especially biological and bacteriological signs, have regressed.

6.9. Length of hospital stay
In this series, the average length of hospital stay was 16.61 ±13.79 days, with extremes of 3 and 150 days, the majority of patients staying for more than 20 days, at a rate of 27.29%. These results differ from those of several authors [4,

7, 10] who reported shorter durations ranging from 7 to 12 days. In daily practice, patients who have undergone surgery may remain in the hospital longer in the event of a complication, especially an infectious complication, in order to monitor the regression of clinical and paraclinical signs. Sometimes socio-economic difficulties lead to a longer stay.

6.10. Mortality

The mortality rate was 17.65%. These results are lower than those observed by Souaré *et al.* in Guinea Conakry in 2023, who found a mortality rate of 22.22% [8]. They are similar to those of Ekouele *et al.* in Congo in 2016, who reported a mortality rate of 17.23% [11]. They are higher than those reported by Diop *et al.* in Senegal in 2020, who found a mortality rate of 2.80% [9], and by Doleagbenou *et al.*, who found a mortality rate of 6.25% in Togo in 2016 [10].

This difference could be explained by the size of our sample, which was larger than that of most of the authors mentioned above, or by non-compliance with treatment due to a lack of financial resources in some cases.

7. Conclusion

Postoperative infections in neurosurgery are rare, but serious when they occur. They occur predominantly in men. Cranial surgery predominates, particularly surgery involving the implantation of devices (drains, valves, osteosynthesis devices). The infectious syndrome is the main clinical manifestation. Meningitis is the most common infection caused by Staphylococcus aureus, the most pathogenic germ. Drug treatment most often involves dual antibiotic therapy. Treatment lasts several weeks and reoperation is often performed, with unfavorable outcomes in half of cases. These infections are responsible for high financial costs. The factors influencing the occurrence of postoperative infections identified in this study were: high blood pressure, transfer from another department, long duration of surgery, and a long postoperative hospital stay of more than 15 days.

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