The Journal of Neurological and Neurosurgical Nursing
Pielęgniarstwo Neurologiczne i Neurochirurgiczne

Wydawnictwo Państwowej Akademii Nauk Stosowanych we Włocławku
ul. Mechaników 3, pok. 20
87-800 Włocławek

eISSN 2299-0321 ISSN 2084-8021
https://apcz.umk.pl/PNIN

DOI: 10.15225/PNN.2024.13.2.4 JNNN 2024;13(2):69–77 Original

Epidemiological and Microbiological Characteristics of Nosocomial Infections in the Neurosurgery Department

Charakterystyka epidemiologiczna oraz mikrobiologiczna zakażeń szpitalnych w oddziale neurochirurgii

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Abstract

Introduction. Healthcare-associated infections (HAIs) in neurosurgery departments are a serious problem, especially for patients in severe clinical condition. A high risk of HAIs is associated with medical interventions in the CNS, and brain injury itself is a particularly strong predictor of nosocomial infections.

Aim. The aim of the study was to perform an epidemiological and microbiological analysis of the incidence of infections in the neurosurgery department.

Material and Methods. Retrospective analysis was performed on the records of patients hospitalised in the neurosurgery department between 2019 and 2022. There were 4,267 patients, among whom 114 infections were found in 69 patients. The collected material was analysed statistically.

Results. HAIs accounted for 1.6% of all hospitalised patients, occurring more frequently in men (42%). The infection incidence rate in 2019 was 3.7 and in 2022 — 2.5. The most commonly isolated pathogens were Enterobacterales. The most frequent diagnoses were respiratory tract infections (PN) — 24.56%, followed by bloodstream infections (BSI) — 20.18%, and surgical site infections (SSI) — 17% The percentage of PN (p=028) and SSI (p=0.027) infections decreased from year to year, and increased in BSI (p=0.022); statistically significant data. The mean for GCS differed significantly among patients with gastrointestinal infection (GI), p=0.021, and was highly statistically significant for BSI and PN, p<0.001. The mean for NRS 2002 differed significantly among patients with and without infection, p<0.05.

Conclusions. Nosocomial infections occur in a small percentage of hospitalised patients, some of whom have more than one nosocomial infection. There is a need for epidemiological surveillance and collaboration between infection control specialists and neurosurgery staff to optimise HAI prevention and control. **(JNNN 2024;13(2):69–77)**

Key Words: neurosurgery, nosocomial infections

Streszczenie

Wstęp. Zakażenia szpitalne związane z opieką zdrowotną (HAI) w oddziałach neurochirurgii stanowią poważny problem, zwłaszcza u pacjentów w ciężkim stanie klinicznym. Wysokie ryzyko HAI jest związane z interwencjami medycznymi w OUN, a samo uszkodzenie mózgu jest szczególnie silnym predykatorem zakażeń szpitalnych.

Cel. Celem badań była analiza epidemiologiczna i mikrobiologiczna występowania zakażeń w oddziale neurochirurgii.

Materiał i metody. Analizie retrospektywnej poddano dokumentację pacjentów hospitalizowanych w oddziale neurochirurgii w latach 2019–2022. Było to 4267 pacjentów, wśród których stwierdzono 114 zakażenia u 69 chorych. Zebrany materiał opracowano statystycznie.

Wyniki. HAI stanowiły 1,6% wszystkich hospitalizowanych pacjentów, występując częściej u mężczyzn (42%). Wskaźnik zapadalności na zakażenie w 2019 r. wyniósł 3,7, a w 2022 r. — 2,5. Najczęściej izolowanymi patogenami były bakterie Enterobacterales. Najwięcej rozpoznano zakażeń układu oddechowego (PN) — 24,56%, następnie zdiagnozowano zakażenia krwi (BSI) — 20,18% oraz zakażenia miejsca operowanego (SSI) — 17%. Odsetek zakażeń PN (p=028) oraz SSI (p=0.027) malał z roku na rok, wzrastał w BSI (p=0,022); dane istotne statystycznie. Średnia dla GCS różniła się istotnie w grupie pacjentów z zakażeniem układu pokarmowego (GI), p=0,021, była wysoce istotna statystycznie dla BSI oraz PN, p<0,001. Średnia dla NRS 2002 różniła się istotnie wśród pacjentów z zakażeniem i bez zakażenia, p<0,05.

Wnioski. Zakażenia szpitalne występują w niewielkim odsetku pacjentów hospitalizowanych, niektórzy z nich mają więcej niż jedno zakażenie szpitalne. Istnieje konieczność prowadzenia nadzoru epidemiologicznego oraz współpracy specjalistów ds. kontroli zakażeń z personelem neurochirurgii celem optymalizacji profilaktyki i kontroli HAI. **(PNN 2024;13(2):69–77)**

Słowa kluczowe: neurochirurgia, zakażenia szpitalne

Introduction

Nosocomial infections, also known as healthcare-associated infections (HAIs), are hospital-acquired infections that are most often absent or may be incubating at the time of hospital admission; these infections are usually acquired post-hospitalisation and manifest 48 hours after hospital admission [1]. HAIs include central line-associated bloodstream infections (CLABSIs), catheter-associated urinary tract infections (CAUTIs), surgical site infections (SSI), hospital-acquired pneumonia (HAP), ventilator-associated pneumonia (VAP) and Clostridium difficile infections (CDIs) [1,2]. The dominant infections include pneumonia (21.8%), surgical site infections (21.8%), gastrointestinal infections (17.1%), urinary tract infections or UTIs (12.9%) and primary bloodstream infections (9.9%), including catheter-associated bloodstream infections [1,3]. Among the pathogens causing HAIs, the leading pathogen is C. difficile (12.1%), closely followed by Staphylococcus aureus (10.7%), Klebsiella (9.9%) and Escherichia coli (9.3%) [1,3]. Skin and surgical site infections are usually caused by Staphylococcus aureus and sometimes include methicyllin-resistant Staphylococcus aureus (MRSA) [1].

Patients staying in neurosurgical wards are at risk of healthcare-associated infections, mainly surgical site infections (SSIs) and other types of treatment-associated infections [4]. A high risk of HAIs is associated with medical interventions in the central and peripheral nervous system, with traumatic brain injury being a particularly strong risk factor [4,5]. Therefore, the care of the neurocritical patient is aimed at avoiding agents that cause secondary brain damage, which is one element of HAI prevention and control in this patient group [4,6]. Other risk factors for HAIs are the use of invasive devices such as central venous catheters (CVCs), urinary catheters (UCs) and mechanical ventilation (MV) [4,7,8].

Transmission of pathogens into the healthcare environment can occur through direct contact with a healthcare worker or directly, through a contaminated environment [1]. The most common risk factors for HAIs are, in turn, related to the clinical condition of the patient, the architectural conditions of the hospital, the hospital environment, the procedures used and the organisation of staff work [9,10].

Nannies are in a unique position to inspire and implement change and raise standards of patient care, including in the area of nosocomial infections. By using their knowledge, skills and competences to carry out effective and timely infection control activities, nurses can demonstrate leadership in preventing and managing the spread of infection in all roles and situations and maintain strict patient safety standards [10–12]. An awareness of the epidemiological and microbiological characteristics of department-clinic (workplace) nosocomial infections and the factors that lead to them is necessary to carry out these tasks.

The aim of this study was to present the epidemiological and microbiological characteristics of nosocomial infections of the neurosurgery department and selected risk factors.

Material and Methods

Retrospective analysis was performed on the records of patients hospitalised between 2019 and 2022 in the Clinic of Neurosurgery and Neurology — Department of Neurosurgery at the Jan Biziel University Hospital No. 2 in Bydgoszcz (Table 1). There were a total of 4,267 patient histories, among which 114 nosocomial infections were found in 69 patients (a given patient had one or more infections). Hence, the study group consisted of 69 patients. These patients had a bacterial or fungal infection; infections of viral aetiology were not studied. The study also included a control group of 78 people without infection, based on which observations were weighted using statistics.

Firstly, the sociodemographic data of the study group were collected. The age of the subjects ranged from 28–99 years, the mean age of the infected patients was

Table 1. Numerical values and statistical parameters of infections occurring in the department

Numerical values	2019	2020	2021	2022	Total
N hospitalisations	1053	838	1099	1277	4267
N hospital-acquired infections (HAI)	39	24	28	23	114
N patients with HAI	21	16	18	14	69
HAI — % of hospitalisations	2.0	1.9	1.6	1.1	1.6
Infection incidence rate*	3.7	2.86	2.55	1.80	2.72
Statistical parameters	**Value**		**df**	**Asymptotic significance (two-sided)**	
Pearson's Chi-square (χ^2)	3.571		3	.312	
Yates's correction for continuity	3.578		3	.289	
Reliability quotient (LR)	3.216		1	.073	
N valid observations	4267		1		
				p>0.05	

*calculated as N infections × 100/N hospitalisations; df — degrees of freedom

63.75. Infection was diagnosed in 69 patients, including 42 men and 27 women.

50% of the infected patients were pensioners, 28% were professionally active, and for 22% of the patients it was not possible to collect information on their employment situation.

46% of the infected patients were in relationships, 29% were single, and for 25% no data on marital status was obtained. The majority of the infected patients — 83% — came from cities, 17% lived in rural areas.

The vast majority of hospitalisations of patients diagnosed with an infection were due to cranial pathology — 90%, and only 10% were due to spinal conditions.

The authors created a questionnaire for the study, which acted as a research tool. The questionnaire consisted of the following parts:

1. Part one — concerned sociodemographic data.
2. Part two — concerned data related to hospitalisation, such as type of treatment, past or ongoing chemotherapy, steroid use, comorbidities, nutritional status according to NRS 2002, consciousness status according to GCS.
3. The third part — addressed the clinical forms of infection:
   - — surgical site infections: SSI,
   - — central nervous system infection: CNS,
   - — bloodstream infections: BSI,
   - — respiratory tract inflammations: PN,
   - — urinary tract infections: UTIS,
   - — gastrointestinal infections: GI,
   - — other.

The analysis was conducted in 2023, obtaining data from the electronic database maintained in the hospital's IT system (medical history, nursing history) and from the documentation maintained by the Nosocomial Infection Team (infection record card).

The condition for the implementation of the study was to obtain a positive opinion from the Bioethics Committee at the Ludwik Rydygier Collegium Medicum in Bydgoszcz, regarding the concept of the presented work (KB No. 182/2022) and the Director of the Jan Biziel University Hospital No. 2 in Bydgoszcz (no. 4172).

The database was prepared in a Microsoft Excel spreadsheet. Statistical analysis was performed using PS IMAGO PRO v. 9 software based on the IBM SPSS Statistics 29 analysis engine.

A significance level of 0.05 was assumed in all analyses. The research problems were verified:

- — the correlation of qualitative variables was checked by Pearson's chi-square test (with correction for continuity in the case of 2×2 tables),
- — the correlation of quantitative and qualitative variables was checked with Student's t-test for independent samples in the version for equal and different variances in the samples, which was further verified with Levene's test for homogeneity of variances.

Results

Epidemiological and Microbiological Data

Between 2019 and 2022, 4,267 patients were treated, of whom 69 were diagnosed with a hospital-associated infection, representing 1.6% of all hospitalised patients; the total number of infections from these years was 114. During the analysed time period, a downward trend was observed in the values of the infection incidence rate, respectively: 3.70; 2.86; 2.55 and 1.80; giving a mean of 2.72 (Table 1).

The most frequent diagnoses were respiratory tract infections, at 28 (24.56%), followed by 23 (20.18%) bloodstream infections, 20 (17.54%) urinary tract infections, 19 (16.67%) surgical site infections, 10 (8.77%) gastrointestinal infections and 9 (7.89%) central nervous system infections. Other infections of other systems were included in the category "other", amounting to 5 (4.39%). The highest number of infections was recorded in 2019 with 39 infections, in 2020 the number was 24, in 2021 — 28, and in 2022 — 23. These data are presented in Table 2.

Table 2. Clinical forms of nosocomial infections in the analysed time interval

Clinical form of infection	2019 N=1053	2020 N=8383	2021 N=1099	2022 N=1277	Total infections	Pearson's Chi² test	Linear relationship test
SSI	8 (0.8%)	5 (0.6%)	4 (0.4%)	2 (0.2%)	19	4.940 (0.176)	4.922 (0.027)
CSN	3 (0.3%)	2 (0.2%)	3 (0.2%)	1 (0.1%)	9	1.401 (0.705)	0.891 (0.345)
BSI	3 (0.3%)	2 (0.2%)	7 (0.6%)	11(0.9%)	23	5.968 (0.113)	5.255 (0.022)
GI	3 (0.3%)	3 (0.4%)	2 (0.2%)	2 (0.2%)	10	1.002 (0.801)	0.609 (0.435)
NP	13 (1.2%)	4 (0.5%)	6 (0.5%)	5 (0.4%)	28	6.928 (0.074)	4.843 (0.028)
UTI	9 (0.9%)	4 (0.5%)	5 (0.5%)	2 (0.2%)	20	5.595 (0.0133)	5.183 (0.023)
Other	0 (0.0%)	4 (0.5%)	1 (0.1%)	0 (0.0%)	5	8.205 (0.042)	0.337 (0.562)
Total patients	21 (2.0%)	16 (1.9%)	18 (1.6%)	14 (1.1%)	69/114	3.571 (0.312)	3.216 (0.073)

N — number of hospitalisations

The percentage of infected patients decreased from year to year, with 2.0% in 2019, 1.9% in 2020, 1.6% in 2021 and 1.1% in 2022. However, the observed differences between the years studied are not statistically significant, Pearson's chi-square test yielded a statistic value of 3.571 and a p-value of 0.312>0.05, a linear relationship test of 3.216 and a p-value of 0.073>0.05 (Table 2).

The percentage of surgical site infections (SSI) decreased from year to year. The chi-square test did not show that the difference between years was statistically significant, Pearson's chi-square test gave a statistic value of 3.571 and a p-value of 0.176>0.05, but the decrease is linear, p-value of the linear relationship test 0.027<0.05 and according to the linear relationship test 4.922 — statistically significant (Table 2).

The difference in central nervous system (CNS) infections over the years studied is not statistically significant, Pearson's chi-square test yielded a statistic value of 1.401 and a p-value of 0.705>0.05, a linear relationship test of 0.891 and a p-value of 0.345>0.05 (Table 2).

The percentage of bloodstream infections (BSI) increased from year to year. The chi-square test did not show that the differences between years were statistically significant, Pearson's chi-square test gave a statistic value of 5.968 and a p-value of 0.113>0.05, but the increase was linear, p-value of the linear relationship test 0.022 <0.05 and according to the linear relationship test 5.255 — statistically significant (Table 2).

The difference in gastrointestinal (GI) infections was not statistically significant, Pearson's chi-square test yielded a statistic value of 1.002 and a p-value of 0.801 >0.05, a linear relationship test of 0.609 and a p-value of 0.435>0.05 (Table 2).

The percentage of respiratory tract infections (PN) decreased from year to year. The chi-square test did not show that the differences between years were statistically significant, Pearson's chi-square test gave a statistic value of 6.928 and a p-value of 0.074>0.05, but the decrease was linear, a p-value of 0.028<0.05 and according to the linear relationship test of 4.843 — statistically significant (Table 2).

The percentage of urinary tract infections (UTIs) decreased from year to year. The chi-square test did not show that the difference between years was statistically significant, Pearson's chi-square test gave a statistic value of 5.595 and a p-value of 0.133>0.05, but the decrease was linear, p-value of the linear relationship test 0.023 <0.05 and according to the linear relationship test 5.183 — statistically significant (Table 2).

The difference in other infections was statistically significant, Pearson's chi-square test yielded a statistic value of 8.205 and a p-value of 0.042<0.05, but neither a linear increase nor a decrease in infections was observed, a linear relationship test of 0.337 and a p-value of 0.562 >0.05. The year 2020 was significantly different from the year before and the year after, with a significantly higher rate of other infections (Table 2).

In the department, the most common pathogens cultured from swabs taken were Enterobacterales, with a total of 189 cases in the analysed time period; this group was dominated by the ESBL strain (63 infections) and HLGR/HLAR — 26 infections. Staphylococcus aureus was the next most common pathogen; the MRSA strain was reported in only 2 cases. There was also a significant number of enterococcal infections, with 46 cases, including three cases of VRE https://pl.wikipedia.org/wiki/J%C4%99zyk_angielski (Vancomycin-Resistant Enterococci). These are bacterial strains that have developed a resistance mechanism to the glycopeptides-vancomycin or teicoplanin. Detailed data are presented in Table 3.

Table 3. Microbiological data of nosocomial infections

Variable		2019	2020	2021	2022	Total
Most commonly isolated pathogens						
Staphylococcus aureus		26	22	10	11	69
Enterococcus spp.		14	6	8	18	46
Enterobacterales		68	44	45	32	189
Pseudomonas aeruginosa		6	5	10	13	34
Acinetobacter spp.		3	0	4	1	8
Mechanisms of microbial resistance						
Enterobacterales	ESBL	21	13	21	8	63
	MBL (incl. NDM)	0	1	4	0	5
Psudomona aeruginosa, Acinetobacter baumannii	MBL	0	0	3	0	3
Staphylococcus aureus	MRSA	0	2	0	0	2
Enterococcus spp.	VRE	3	0	0	0	3
Enterobacterales	HLGR/HLAR	6	3	3	14	26
	ESBL	21	13	21	8	63
	MBL (incl. NDM)	0	1	4	0	5

Selected Patient-related Risk Factors and Incidence of Infections

The following analysis concerned risk factors such as type of treatment, past or ongoing chemotherapy, steroid use, comorbidities, nutritional status according to NRS 2002 scale, and GCS status.

Surgical treatment was given to 3,523 patients, of whom 60 had an infection; infected patients accounted for 1.7% of all patients who underwent surgery. Conservative treatment was given to 744 patients, 9 of whom became infected, representing 1.2% of those treated non-operatively. Surgical site and central nervous system infections occurred only in surgical patients. For none of the infections considered, the treatment used is statistically significant, the correction for the continuity of the p-value always being >0.05. The data are presented in Table 4.

Eight patients became infected after or during chemotherapy, accounting for 5% of all patients who were treated with this modality. The overall infection rate was much higher when having or continuing chemotherapy and the differences were statistically significant, Pearson's chi-square test with correction for continuity gave a statistic value of 9.728 and a p-value of 0.002<0.05 (Table 5).

The difference in the percentage of central nervous system, respiratory and gastrointestinal infections in patients who are undergoing or have undergone chemotherapy is statistically significant, Pearson's chi-square test with correction for continuity gave a p-value of <0.05 (Table 5).

The difference in the rate of bloodstream, surgical site, urinary tract and other infections in patients who are undergoing or have undergone chemotherapy is not statistically significant, Pearson's chi-square test with correction for continuity gave a p-value of >0.05 (Table 5).

Seven patients on steroids became infected, representing 13% of all patients who were treated with steroids. The overall infection rate was much higher with steroid treatment and the differences were statistically

Table 4. Effect of type of treatment on number of people infected and infections

Number of infections	Procedural treatment	Conservative treatment	Pearson's chi-square test with correction for continuity
	N (%)	N (%)	Value (significance)
Total infected	60 (1.7%)	9 (1.2%)	0.655 (0.418)
SSI	19 (0.6%)	0 (0.0%)	2.992 (0.084)
CSN	9 (0.3%)	0 (0.0%)	0.920 (0.337)
BSI	20 (0.6%)	3 (0.4%)	0.103 (0.749)
GI	8 (0.2%)	2 (0.3%)	0.000 (1.000)
NP	25 (0.7%)	3 (0.4%)	0.535 (0.465)
UTI	17 (0.5%)	3 (0.4%)	0.001 (0.975)
Other	4 (0.1%)	0 (0.0%)	0.076 (0.783)

Table 5. Effect of chemotherapy on number of people infected and infections

Number of infections	Chemotherapy No	Chemotherapy Yes	Pearson's chi-square test with correction for continuity
	N (%)	N (%)	Value (significance)
Total infected	61 (1.5%)	8 (5.0%)	9.728 (0.002)
SSI	17 (0.4%)	2 (1.2%)	0.847 (0.357)
CSN	7 (0.2%)	2 (1.2%)	4.012 (0.045)
BSI	23 (0.6%)	0 (0.0%)	0.175 (0.676)
GI	7 (0.2%)	3 (1.9%)	12.137 (<0.001)
NP	24 (0.6%)	4 (2.5%)	5.713 (0.017)
UTI	18 (0.4%)	2 (1.2%)	0.727 (0.394)
Other	4 (0.1%)	0 (0.0%)	0.000 (1.000)

Table 6. Steroid use and the number of infections and people infected

Number of infections	Steroid use No	Steroid use Yes	Pearson's chi-square test with correction for continuity
	N (%)	N (%)	Value (significance)
Total infected	62 (1.5%)	7 (13%)	37.326 (<0.001)
SSI	16 (0.4%)	3 (5.6%)	21.124 (<0.001)
CSN	8 (0.2%)	1 (1.9%)	1.290 (0.256)
BSI	20 (0.5%)	3 (5.6%)	16.677 (<0.001)
GI	8 (0.2%)	2 (3.7%)	14.805 (<0.001)
NP	25 (0.6%)	3 (5.6%)	12.924 (<0.001)
UTI	19 (0.5%)	1 (1.9%)	0.231 (0.630)
Other	4 (0.1%)	0 (0.0%)	0.000 (1.000)

Table 7. Comorbidities and people infected and infections

Comorbidity	Comorbidities No	Comorbidities Yes	Pearson's chi-square test with correction for continuity
	N (%)	N (%)	Value (significance)
Neoplastic disease	60 (1.5%)	9 (3.7%)	5.857 (0.016)
Hypertension	40 (1.4%)	29 (2.0%)	1.428 (0.232)
Coronary heart disease	62 (1.6%)	7 (2.6%)	1.196 (0.274)
Alcohol dependence syndrome	59 (1.4%)	10 (5.5%)	15.669 (<0.001)
Diabetes	57 (1.5%)	12 (2.6%)	2.551 (0.110)

significant, Pearson's chi-square test with correction for continuity yielded a statistic value of 37.326 and a p-value of <0.001. The data are presented in Table 6.

The difference in the rates of central nervous system infections, urinary tract infections and other infections in patients who used steroids was not statistically significant; the p-value of Pearson's chi-square continuity correction was always >0.05 (Table 6).

The difference in rates of bloodstream, surgical site, respiratory and gastrointestinal infections in patients who used steroids was statistically significant; the p-value of Pearson's chi-square continuity correction was <0.001 in these cases (Table 6).

It was examined whether patients' comorbidities affect the incidence of infections. The study considered neoplastic disease, hypertension, coronary heart disease, diabetes, and alcohol dependence syndrome. The results are presented in Table 7.

It was shown that the difference in the percentage of infected patients with neoplastic disease and alcohol dependence syndrome was statistically significant, with a p-value of the Pearson chi-square test with continuity correction of <0.05 (Table 7).

Hypertension, coronary heart disease and diabetes did not affect the infection incidence rate. The difference in the proportion of infected patients with the listed diseases was not statistically significant; the p-value of Pearson's chi-square test with correction for continuity was >0.05 (Table 7).

It was found that the nutritional status on admission, assessed using the NRS 2002 scale, had an impact on the incidence of infection. Infected patients had a mean score of 2.75 while uninfected ones had a mean score of 0.65. The results were statistically significantly different in the overall infected and uninfected group; p-value two-sided <0.001. The data are presented in Table 8.

In all infections studied, the mean for the NRS 2002 was statistically significantly different in the infected and uninfected patients; p-value two-sided <0.05. In all cases, the mean values among the infected were higher than in the non-infection group (Table 8).

Mean GCS scale scores were statistically significantly different in the overall group of infected and uninfected

Table 8. Nutritional status according to the NRS 2002 scale and the number of people infected and infections

Nutritional status according to the NRS 2002 scale	Patients with infection	Patients without infection	Student's t-test
	M/SD	M/SD	Value (significance)
Total infected	2.75 (1.151)	0.65 (0.970)	17.624 (<0.001)
SSI	1.94 (1.392)	0.69 (1.008)	3.805 (0.009)
CNS	2.33 (1.000)	0.70 (1.010)	4.857 (<0.001)
BSI	3.13 (0.694)	0.69 (0.998)	16.783 (<0.001)
NP	2.93 (0.979)	0.68 (0.996)	11.877 (<0.001)
UTI	3.10 (0.852)	0.69 (1.000)	10.769 (<0.001)
GI	3.00 (0.816)	0.69 (1.007)	7.234 (<0.001)
Other	2.75 (1.893)	0.70 (1.010)	4.058 (<0.001)

M — mean; SD — standard deviation

Table 9. Consciousness status according to GCS scale and the number of people infected and infections

GCS Scale	Patients with infection	Patients without infection	Student's t-test
	M/SD	M/SD	Value (significance)
Total infected	11.07 (4.360)	14.35 (2.068)	–6.142 (<0.001)
SSI	13.78 (2.756)	14.29 (2.176)	–0.995 (0.217)
CNS	11.67 (4.822)	14.29 (2.168)	–1.634 (0.141)
BSI	9.73 (4.813)	14.31 (2.132)	–4.466 (<0.001)
NP	10.07 (4.859)	14.31 (2.125)	–4.532 (<0.001)
UTI	9.40 (4.477)	14.31 (2.136)	–4.903 (<0.001)
GI	10.40 (4.427)	14.30 (2.164)	–2.783 (0.021)
Other	7.50 (5.447)	14.29 (2.165)	–2.495 (0.088)

M — mean; SD — standard deviation

patients, p-value two-sided <0.001. Infected patients had lower mean scores (–11.07) compared to uninfected ones (14.35) (Table 9).

The mean for GCS was statistically significantly different in the group of patients with gastrointestinal infection, p-two-sided value 0.021<0.05 and highly statistically significant for bloodstream, respiratory and urinary tract infections, p-two-sided value <0.001. For infected patients, the mean value was lower than for uninfected patients, the lowest being for urinary tract infections at 9.40 (Table 9).

For central nervous system infections and others, the results were not statistically significant, p-two-sided value >0.05 (Table 9).

Discussion

Nosocomial infections are a serious health problem and a threat to the health and lives of patients. HAIs can be prevented by using recognised preventive measures. A fundamental step in infection prevention planning is to know the risk factors.

During the analysed years 2019–2022, 4267 patients were hospitalised, 69 patients became infected, representing 1.6% of all patients. The incidence rate of infection was 2.73. In studies with similar themes, the incidence rate value for infections in neurosurgical patients oscillated between 1.99 and 6.67 [4,13–16].

114 infections were detected in the department, the most common clinical forms being respiratory infection (24.56% of all infections), bloodstream infection (20.18%), urinary tract infection (17.54%) and surgical site infection (16.67%). Elżbieta Rafa and co-authors in a study covering 2014–2019 obtained similar results — respiratory tract infection was the most common of 373 hospital-acquired infections, followed by urinary tract infection, surgical site infection and blood infection [4]. Kołpa and co-researchers in their study covering the period 2003–2017 examined 10 332 patients attending a neurosurgical department, of whom 476 were diagnosed with an infection. The most common forms of infection were surgical site, respiratory, blood and urinary tract infections [16]. The studies cited above identify the four most common infections in neurosurgical departments.

Selected patient-related risk factors were investigated: type of treatment, past or ongoing chemotherapy, steroid use, comorbidities, nutritional status according to NRS 2002 scale, and GCS status.

Data were collected on comorbidities and their possible impact on the incidence of infections. The following were considered: neoplastic disease, hypertension, coronary heart disease, alcohol dependence syndrome and diabetes. Statistical analysis showed that only neoplastic disease and alcohol dependence syndrome determined the incidence of infections. In an article on factors influencing nosocomial infections in postoperative patients with intracranial aneurysms, as in the author's study, there was no association of hypertension, diabetes and coronary heart disease on the incidence of infections [8].

Upon admission, the patient's level of consciousness is evaluated using the 15-point Glasgow Coma Scale (GCS), a crucial assessment indicating the severity of the patient's condition. The study found that patients with lower scores on the scale described above had a higher rate of nosocomial infections. The average for infected patients was 11.07, while patients without infections scored 14.35. Similar results were obtained by Göçmez and co-authors in their study of risk factors for nosocomial infections in a neurosurgical intensive care unit [17]. They found that patients with infections scored lower on the GCS scale (average 11.4 points) than patients without infections (average 13.3 points). Cuneyt Gocmez's work also investigated that longer duration of hospitalisation, reoperations and the use of an artificial airway have an impact on the incidence of infections, which was also observed in the author's work [17].

An important risk factor for nosocomial infections appeared to be nutritional status, which was assessed on admission using the NRS 2002 scale. Patients with infection were characterised by a higher mean score (2.75) than patients without infection (0.65). In the authors' study, mean values of 3 or above on the NRS 2002 scale were obtained by patients diagnosed with blood, urinary tract and gastrointestinal tract infections. Similar results were obtained by Chen and co-researchers in a study screening for nutritional risk on the NRS 2002 scale and the incidence of infection associated with ischaemic stroke. This study found that patients with an NRS 2002 score greater than or equal to 3 were at higher risk of developing an infection [18].

It was also shown that patients during or after chemotherapy and also treated with steroids were more likely to develop nosocomial infections. It was also investigated that the number of treatments on the unit had an impact on the incidence of infection, the average number of treatments being higher for patients with infection (1.90) than those without infection (0.82). The highest number of procedures was carried out in patients who were subsequently diagnosed with a central nervous system infection (average 3.78), also in this group of patients the mean number of days of drainage maintenance was the highest (average 25.43).

Conclusions

1. Nosocomial infections occur in a small percentage of hospitalised patients, some of whom have more than one nosocomial infection.
2. The predominant clinical form was respiratory infections, followed by bloodstream infections, then urinary tract infections and surgical site infections. The most commonly isolated pathogens were Enterobacterales.
3. The development of nosocomial infections can be predicted in patients with altered consciousness, malnutrition, undergoing chemotherapy or post-chemotherapy, as well as in patients treated with steroids.

Implications for Nursing Practice

Infection prevention is a key responsibility of healthcare staff, who also have a vital role in educating patients and ensuring that all elements of nursing practice are supported by the latest scientific knowledge [10]. There is a need for epidemiological surveillance and collaboration between infection control specialists and neurosurgery staff to optimise infections prevention and control.

References

[1] Monegro A.F., Muppidi V., Regunath H. *Hospital-Acquired Infections* (updated February 12, 2023). Retrieved April 19, 2024, from https://www.ncbi.nlm.nih.gov/books/NBK441857/

[2] Boev C., Kiss E. Hospital-Acquired Infections: Current Trends and Prevention. *Crit Care Nurs Clin North Am*. 2017;29(1):51–65.

[3] Magill S.S., Edwards J.R., Bamberg W. et al. Multistate point-prevalence survey of health care-associated infections. *N Engl J Med*. 2014;370(13):1198–1208.

[4] Rafa E., Kołpa M., Wałaszek M.Z. et al. Healthcare-Acquired Infection Surveillance in Neurosurgery Patients, Incidence and Microbiology, Five Years of Experience in Two Polish Units. *Int J Environ Res Public Health*. 2022;19(12):7544.

[5] Busl K.M. Nosocomial Infections in the Neurointensive Care Unit. *Neurol Clin*. 2017;35(4):785–807.

[6] Spatenkova V., Bradac O., Fackova D., Bohunova Z., Suchomel P. Low incidence of multidrug-resistant bacteria and nosocomial infection due to a preventive multimodal nosocomial infection control: a 10-year single centre prospective cohort study in neurocritical care. *BMC Neurol*. 2018;18(1):23.
[7] Wałaszek M. The analysis of the occurrence of nosocomial infections in the neurosurgical ward in the District Hospital from 2003 to 2012. *Przegl Epidemiol*. 2015; 69(3):507–514.
[8] Wang J., Ji Y., Jiang L. et al. Analysis of factors influencing hospital-acquired infection in postoperative patients with intracranial aneurysm. *BMC Neurol*. 2019;19(1):332.
[9] Ziółko A. Czynniki ryzyka związane z rozpoznawaniem i zapobieganiem zakażeniom szpitalnym. *Forum Zakażeń*. 2016;7(2):109–113.
[10] Kubde D., Badge A.K., Ugemuge S., Shahu S. Importance of Hospital Infection Control. *Cureus*. 2023;15(12): e50931.
[11] Sodhi K., Shrivastava A., Arya M., Kumar M. Knowledge of infection control practices among intensive care nurses in a tertiary care hospital. *J Infect Public Health*. 2013; 6(4):269–275.
[12] Huang F., Brouqui P., Boudjema S. How does innovative technology impact nursing in infectious diseases and infection control? A scoping review. *Nurs Open*. 2021;8(5): 2369–2384.
[13] Wieder-Huszla S., Jurczak A., Sołowiej S. i wsp. Analiza częstości występowania zakażeń szpitalnych w oddziale neurochirurgii. *Probl Hig Epidemiol*. 2013;94(3):547–550.
[14] Agarwal R., Mohapatra S., Rath G.P., Kapil A. Active Surveillance of Health Care Associated Infections in Neurosurgical Patients. *J Clin Diagn Res*. 2017;11(7): DC01–DC04.
[15] Kołpa M., Wałaszek M., Różańska A., Wolak Z., Wójkowska-Mach J. Epidemiology of Surgical Site Infections and Non-Surgical Infections in Neurosurgical Polish Patients — Substantial Changes in 2003–2017. *Int J Environ Res Public Health*. 2019;16(6):911.
[16] Kołpa M., Wałaszek M., Różańska A., Wolak Z., Wójkowska-Mach J. Hospital-Wide Surveillance of Healthcare-Associated Infections as a Source of Information about Specific Hospital Needs. A 5-Year Observation in a Multiprofile Provincial Hospital in the South of Poland. *Int J Environ Res Public Health*. 2018; 15(9):1956.
[17] Göçmez C., Çelik F., Tekin R. et al. Evaluation of risk factors affecting hospital-acquired infections in the neurosurgery intensive care unit. *Int J Neurosci*. 2014; 124(7):503–508.
[18] Chen X., Li D., Liu Y., Zhu L., Jia Y., Gao Y. Nutritional risk screening 2002 scale and subsequent risk of stroke-associated infection in ischemic stroke: The REMISE study. *Front Nutr*. 2022;9:895803.

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Conflict of Interest: None
Funding: None
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Received: 15.01.2024
Accepted: 28.02.2024