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THE ANALYSIS OF THE OCCURENCE OF NOSOCOMIAL INFECTIONS IN THE NEUROSURGICAL WARD IN THE DISTRICT HOSPITAL FROM 2003 TO 2012*

The St. Lukas District Hospital in Tarnów

SUMMARY

INTRODUCTION. The patients in the neurosurgical ward are exposed to many risk factors causing nosocomial infections. These factors are related to operations, invasive diagnosing and monitoring of the nervous system and mechanical support of vital functions. Therefore, the objective of the undertaken studies was to assess the prevalence and structure of the healthcare-associated infections (HAI) in patients hospitalized in the neurosurgical ward in the St. Lukas District Hospital in Tarnów.

MATERIAL AND METHODS. The analyzed data concerned 13,351 patients hospitalized from 2003 to 2012. To analyze the data, the standard epidemiological methods and standardized definitions of nosocomial infections proposed by European Center for Disease Prevention and Control (ECDC) were used (1, 2).

RESULTS. 516 cases of nosocomial infections were detected. The most common infections among these cases were surgical site infections (SSI). The number of SSIs cases was 140 and cumulative incidence rate (CI) per 100 operations was 1.72%, including: 52 cases of craniotomy (CRAN) (CI per 100 operations was 2.44%); 50 cases of spinal fusion (FUSN) (CI was 3.32%); 24 cases of laminectomy (LAM) (CI was 0.93%); 10 cases of ventricular shunt operations (VSHN) (CI was 3.75%); 4 cases of other operations (OTH) (CI was 0.23%). The second most common infections were bloodstream infections (BSI) with 128 cases (CI was 0.96%), including: 91 cases of primary BSI and 37 cases of secondary BSI and the incidence density rate (ID) was 4.75 per 1000 central catheter days. The third most common infection was pneumonia (PN) with 127 cases (CI was 1.02%), with incidence density rate of 51.07 per 1000 intubation-days. The next most common detected infections were urinary tract infections (UTI) with 74 cases (CI was 0.58%). This type of infections included: 65 cases of infections associated with a urinary catheter and 9 cases not associated with a urinary catheter. The incidence density for UTI with a urinary catheter was 1.93 per 1000 urinary catheter days. The list of detected infections is closed by gastrointestinal system infections (GI) with 35 cases (CI was 0.23%) and the skin and soft tissue infections (SST) with 12 cases (CI was 0.07%). The etiological agent that was most frequently isolated from materials gathered from patients diagnosed with SSI, BSI and SST was *Staphylococcus aureus*. *Acinetobacter baumannii* was the most frequently detected in the cases of PN, *Escherichia coli* in the cases of UTI, and *Clostridium difficile* in the cases of GI.

CONCLUSIONS. Ten-year observation of infections detected in the neurosurgery ward gave the possibility to conduct a thorough epidemiological analysis of prevalence of nosocomial infections with recommendation aiming at reasons for prevention.

Key words: *nosocomial infections (HAI), neurosurgery, surgical site infections, bloodstream infections, urinary tract infections, pneumonia*

INTRODUCTION

In the neurosurgical wards, the surgical interventions performed on the sensitive nerve tissue generate many risk factors for developing postoperative complications. One of these complications can be nosocomial infections, which in the neurosurgical wards most often occur in the form of surgical site infections. Equally often during patent's hospitalization other forms of serious nosocomial infections are detected, such as: bloodstream infections, pneumonia, urinary tract infections, they are directly related to the provided invasive

treatment. These infections pose a significant medical, ethical and economic problem, they can cause a serious damage to health and even permanent disability of a patient. In Poland there are few publications discussing the issues of prevalence of nosocomial infections in patients treated neurosurgically. The conducted study of the structure and prevalence of nosocomial infections in the neurosurgical ward aimed at setting the priority directions of preventive measures. The specific objectives included the specification of: morbidity rate of nosocomial infections, clinical forms of infections, morbidity rate of nosocomial infections for the selected medical procedures and the etiological agents of infections.

MATERIAL AND METHODS

The study included 13,351 patients hospitalized in the neurosurgical ward in the St. Lukas District Hospital in Tarnów from 2003 to 2012. In the diagnosing and classifying the infections in the initial period of surveillance, the definitions formulated by Centers for Disease Control and Prevention (CDC) were used. The definitions were issued in the Polish language version by Polish Society of Hospital Infections (Polskie Towarzystwo Zakażeń Szpitalnych) (1). For the purpose of this paper, in order to determine the clinical forms of detected infections, the revision of back-data about infections in the neurosurgical ward including ECDC definitions was conducted (2, 3).

The registry of detected infections used the classification of infections into the following clinical forms of infections: surgical site infection (SSI), pneumonia (PN), urinary tract infection (UTI), bloodstream infection (BSI), gastrointestinal system infection (GI), other infections (OTH). In this study, the neurosurgical operations are classified according to International Classification of Diseases (ICD 9-CM -).

The ICD 9-CM operational procedures were mapped for the purpose of surveillance over infections in accordance with CDC and ECDC guidelines. Six groups of neurosurgical operations were distinguished as a result of the used division: LAM – laminectomy, FUSN – spinal fusion, RFUSN – refusion of spine, CRAN – craniotomy, VSHN - ventricular shunt operations, including revision and removal of shunt, OTH – other operations (2, 4). Information about patients with nosocomial infections was collected with the use of an active surveillance method through daily analysis of microbiological and analytical test results, review of patient's documentation, consultation with doctors and liaison nurses. Data about the treatment of patients were obtained by using an electronic database in the hospital system – InfoMedica. The cumulative incidence rate was used in order to assess the epidemiological situation of nosocomial infections. The cumulative incidence rate was calculated by giving a number of new cases of HAI in the studied population in the time unit according to the formula: the number of HAI cases divided by the number of operations multiplied by 100 for SSI and the number of hospitalizations multiplied by 100 for the other forms of nosocomial infections. Density incidence/1000 (DI) was also calculated. It describes the number of BSI divided by the number of person-days when the invasive devices were used. These factors provide information about the intensity of infection prevalence. Microbiological tests were conducted on patients with suspected nosocomial infection. The following clinical material was collected for the microbiological tests: blood, urine, swab from the wound, faces, bronchial aspirate, bronchial alveolar lavage BAL, the tips of vascular catheters and others. The identification of staphylococci, bacilli from the *Enterobacteriaceae* family, non-fermenting bacillus and yeast-like fungi was made with the use of Vitek 2 Compact – the automatic identification system (the bioMérieux company).

RESULTS

13,351 patients were hospitalized during the study period from 2003 to 2012 in the neurosurgery ward in the St. Lukas District Hospital in Tarnów. The total number of patients included 7076 men (53%) and 6253 (47%) women. The average age of hospitalized patients was 52

Table I. Healthcare-associated infections (HAI) diagnosed in patients who were treated surgically and conservatively on the neurosurgical ward from 2003 to 2012 (number of patients and HAI cases).

Patients	All hospitalized patients		Patients treated surgically		Patients treated conservatively	
	n	%	n	%	n	%
Patients without HAI	12936	96.89	7797	95.64	5139	98.84
Patients with 1 HAI	334	2.5	286	3.5	48	0.92
Patients with 2 HAIs	61	0.45	53	0.65	8	0.15
Patients with 3 HAIs	14	0.1	10	0.12	4	0.07
Patients with 4 HAIs	6	0.04	6	0.07	0	0
Patients with HAI (total)	415	3.11	355	2.66	60	1.16
Patients without HAI	12936	96.89	7797	95.64	5139	98.84
Total	**13351**	**100**	**8152**	**100**	**5199**	**100**

Table II. Healthcare-associated infections (HAI). The number of patients and cumulative incidence rate (CI) on the neurosurgical ward from 2003 to 2012.

Year	Number of HAI cases	Number of patients	CI %	Number of operations	Patients with SSI		Patients with BSI		Patients with PN		Patients with UTI		Patients with GI		Patients with SST	
					n	CI %	n	CI %	n	CI %	n	CI %	n	CI %	n	CI %
2003	34	725	4.69	334	10	2.99	6	0.83	10	1.38	7	0.97	1	0.14	0	0
2004	53	879	6.03	497	12	2.41	15	1.71	21	2.39	5	0.57	0	0	0	0
2005	37	880	4.2	532	13	2.44	10	1.14	9	1.02	5	0.57	0	0	0	0
2006	46	941	4.89	549	14	2.55	17	1.81	5	0.53	8	0.85	1	0.11	1	0.11
2007	45	1259	3.57	861	9	1.05	10	0.79	16	1.27	1	0.08	9	0.71	0	0
2008	44	1509	2.92	943	10	1.06	15	0.99	11	0.73	4	0.27	0	0	4	0.27
2009	58	1464	3.96	906	20	2.21	11	0.75	7	0.48	13	0.89	6	0.41	1	0.07
2010	58	1679	3.45	1128	14	1.24	12	0.71	9	0.54	10	0.6	12	0.71	1	0.06
2011	67	1937	3.46	1167	19	1.63	13	0.67	22	1.08	6	0.31	5	0.26	3	0.15
2012	74	2078	3.56	1237	19	1.54	19	0.91	17	0.82	15	0.72	1	0.05	2	0.1
Total	**516**	**13351**	**3.86**	**8153**	**140**	1.72	**128**	**0.96**	**127**	**1.02**	**74**	**0.58**	**35**	**0.23**	**12**	**0.07**

CI – cumulative incidence, SSI – surgical site infections, BSI – bloodstream infections, PN – pneumonia, UTI – urinary tract infections, GI – gastrointestinal system infection, SST – skin and soft tissue infections.

years, and the average age of patients with healthcare-associated infections (HAI) was 55 years. On average, the patients stayed on the ward for 8.1 days. HAI was detected more frequently in patients treated surgically, in this group the infections were diagnosed in 335 patients. Whereas in the group of patients treated conservatively the infections were diagnosed in 60 patients. Among the patients diagnosed with nosocomial infections, 334 (2.5%) patients had diagnosed one form of the infection, 61 (0.5%) patients had diagnosed two forms of the infection, 14 (0.1%) patients had diagnosed three forms of the infection and 6 patients (0.04%) had diagnosed four forms of HAI. The total number of detected nosocomial infections was 516 in 415 patients, which means that some patients had more than one nosocomial infection (Table I). Operations were performed to 8,153 (61%) patients and 5,198 (39%) patients underwent conservative treatment. HAI incidence rate was higher in men than in women. In the study period, the average cumulative incidence (CI per 100 hospitalizations) was 3.86%, and was the highest in 2004 (6.03%) and the lowest in 2008 (2.92%). Among all patients treated on the neurosurgical ward the number of detected SSI cases was 140, cumulative incidence (CI per 100 hospitalizations) for SSI was 1.72%. The number of detected BSI cases was 128, the cumulative incidence (CI per 100 hospitalizations) for BSI was 0.96%. The number of detected pneumonia cases was 127 with the cumulative incidence of 1.02%. The number of detected cases of UTI was 74 with the incidence rate of 0.58%. The cases of GI and SST were the least frequent with the low cumulative incidence (Table II). All clinical forms of HAI were diagnosed in patients who underwent operations and cumulative incidence was 5.4%. In most cases the infections were diagnosed in patients who had ventricular shunt operations (VSHN) – 47 cases (17.7%). In this group the most frequent infections were pneumonia – 15 cases and urinary tract infections – 11 cases. The second group of patients who underwent operations and were diagnosed with infection were patients who had craniotomy – 245 cases (11.5%). In this group the most frequently detected infections were pneumonia – 80 cases and bloodstream infections – 65 cases. Surgical site infections were most often diagnosed among patients who underwent spinal operations such as laminectomy (LAM) and spinal fusion (FUSN) (Table III).

Table III. Healthcare-associated infections (HAI) in patients who underwent operations on the neurosurgical ward from 2003 to 2012. The types and number of operations and the type of HAI.

Type of operation	LAM	FUSN	CRAN	VSHN	OTH	Total
Number of operations	2575	1502	2129	266	1669	8152
SSI (n)	24	50	52	10	4	140
BSI (n)	9	15	65	8	0	97
PN (n)	0	8	80	15	0	103
UTI (n)	13	8	31	11	0	63
GI (n)	6	9	12	3	1	31
SST (n)	0	2	5	0	0	7
Total	52	92	245	47	5	441
Cumulative incidence	2.0	6.1	11.5	17.7	0.3	5.4

n = the number of nosocomial infections, CI – cumulative incidence, SSI – surgical site infection, BSI – bloodstream infection, PN - pneumonia, UTI – urinary tract infection, GI – gastrointestinal system infection, SST – skin and soft tissue infections, LAM – laminectomy, FUSN – spinal fusion, CRAN – craniotomy , VSHN – ventricular shunt operations, OTH – other operations.

Table IV. Incidence density of primary bloodstream infections (BSI-incidence density) associated with central venous catheters and peripheral venous catheters on the neurosurgical ward from 2003 to 2012.

BSI (primary)										
Year	Primary BSI	Number of BSI-CVC	Number of CVC-days	BSI incidence density * associated with CVC	(UR) CVC ratio	Number of BSI-PCV	Number of PVC-days	BSI incidence density * associated with PVC	Number of BSI-UO	Number of BSI-UNK
2003	2	2	476	4.2	0.09	0	4984	0	0	0
2004	12	12	564	21.28	0.06	0	5689	0	0	0
2005	10	1	521	1.92	0.07	8	5345	1.5	1	0
2006	14	5	575	8.7	0.06	9	5876	1.53	0	0
2007	10	0	609	0	0.06	10	6578	1.52	0	0
2008	14	2	666	3	0.06	11	8270	1.33	0	1
2009	5	3	786	3.82	0.08	2	7347	0.27	2	0
2010	3	2	1093	1.83	0.09	1	8594	0.12	0	0
2011	8	3	1094	2.74	0.1	4	11475	0.35	1	0
2012	13	6	1198	5.01	0.11	7	10789	0.65	0	0
Total	**91**	**36**	**7582**	**4.75**	**0.08**	**52**	**74947**	**0.69**	**4**	**1**

Incidence density *- incidence density per 1000 CVC-days, CVC – central venous catheter, PVC – peripheral venous catheter, UO - unknown origin, UNK – missing, unavailable data, UR - central venous catheter utilization ratio

Surgical site infections. 8153 operations were performed, 140 cases of SSI were diagnosed including: 52 cases of SSI per 2129 craniotomies (CI per 100 operations was 2.44 %); 50 cases of SSI per 1502 spinal fusions (CI was 3.32%); 24 cases of SSI per 2575 laminectomies (CI was 0.93%); 10 cases of SSI per 266 ventricular shunt operations (CI was 3.75%); 4 cases of SSI per 1671 other operations (CI was 0.23%).

Bloodstream infections. The number of diagnosed cases of primary bloodstream infections was 91 including 36 cases associated with a central venous catheter (BSI-CVC) and 50 cases associated with a peripheral venous catheter (BSI-PVC) and 5 cases with the unknown source of infection. Incidence density (ID) for BSI-CVC was 4.75 per 1000 central catheter days and incidence density for BSI-PVC was 0.67 per 1000 PVC-days (Table IV). According to the infections surveillance report in the NNIS program 1992-2004, the detected incidence density of BSI-CVC was 4.6/1000 central catheter days and the risk was 0.46 (11). While in the NHSN report from 2006-2008 and 2011 incidence density of BSI-CVC reached lower level: from 0.8 to 0.9/1000 central catheter days and the risk was 0.17 (12, 13). According to the latest HAI surveillance report 2011-2012 published by ECDC (14) the detected incidence of BSI was 3%, and incidence density was 3.5/1000 central catheter days. In the above mentioned study by Maki at al. (15) the incidence of BSI-CVC was 2.7 per 1000 CVC-days. Observational studies conducted by Pronovost at al. (16) in 2010 give hope for reducing bloodstream infections associated with a central venous catheter to zero along with the possibility of maintaining this result for a longer period of time.

Table V. Cases of respirator-associated pneumonia and density incidence (DI per 1000 intubation days) on the neurosurgical ward from 2003 to 2012.

Ventilator-associated PN								
Year	Number of PN	Number of PN-IAP	Number of intubation-days	PN-IAP incidence density* (‰)	(IUR) PN-IAP ratio	Number of PN-HAP	Number of person-days without intubation	PN-HAP incidence density* (‰)
2003	10	7	92	76.09	0.01	3	10983	0.27
2004	21	14	89	157.3	0.01	7	10792	0.65
2005	9	8	97	82.47	0.01	1	10879	0.09
2006	5	4	103	38.83	0.01	1	11097	0.09
2007	16	10	116	86.21	0.01	6	11121	0.54
2008	11	5	133	37.59	0.01	6	11311	0.53
2009	7	4	118	33.9	0.01	3	10270	0.29
2010	9	5	168	29.76	0.01	4	11479	0.35
2011	22	6	192	31.25	0.02	16	11283	1.42
2012	17	6	243	24.69	0.02	11	11375	0.97
Total	**127**	**69**	**1351**	**51.07**	**0.01**	**58**	**110590**	**0.52**

Incidence density *- incidence density per 1000 intubation-days, IAP – intubation associated pneumonia, HAP – pneumonia diagnosed in non-intubated patients, IUR – intubation utilization ratio

Pneumonia. Among 127 patients with diagnosed with nosocomial pneumonia, 69 cases were associated with intubation (PN-IAP according to the definition used by ECDC) or ventilation (PN-VAP according to the definition used by CDC) and 58 cases of non-ventilator associated pneumonia (PN-HAP). Incidence density of intubation-associated pneumonia (PN-IAP) was 51.7 per 1000 intubation-days (Table V). Using the classification of nosocomial pneumonia proposed by CDC, in the studied population 69 cases of VAP (IAP according to the definition used by ECDC) associated with artificial ventilation (intubation) were diagnosed, and 58 cases of hospital acquired pneumonia (HAP) not associated with artificial ventilation. Incidence density for VAP/IAP was 51.07 per 1000 intubation-days and the risk was 0.52. In the infections surveillance report in the NNIS program (ICU) 1992-2004 the detected incidence rate of VAP was 11.2/1000 ventilation-days and the risk was 0.29 (11). In the NHSN program 2006-2008 the detected incidence density was 5.3/1000 person-days and the risk was 0.36 (12). In the European infections surveillance program by ECDC, IAP infections amounted to 6.5 per 1000 intubation-days (14).

Urinary tract infections. In the group of 74 patients with nosocomial urinary tract infections, 65 of diagnosed cases were associated with a urinary catheter and 9 cases were not associated with a urinary catheter. Incidence density for UTI associated with a urinary catheter was 1.93 per 1000 urinary catheter days (Table VI). Incidence density for UTI with a urinary catheter was 1.9 per 1000 urinary catheter days and the risk was 0.31. In the infections surveillance report in the NNIS program 1992-2004 the detected incidence density was 6.7 per 1000 catheter days and the risk was 0.85 (11). In the NHSN 2006-2008 report the incidence density of UTI was 8.8 per 1000 catheter days and the risk was 0.27 and in 2011 the risk was 0.23 (12). The obtained infection rate for UTI on the neurosurgical ward is comparable with the NNIS report and too low in comparison with the NHSN report. In the ECDC report the incidence rate for UTI was 4.1 per 1000 urinary catheter days (14).

Etiological agents of infections. On the basis of additional cultures obtained from patients with infections who were hospitalized on the neurosurgical ward in the studied period, 440 microorganisms were isolated. The isolated microorganisms were qualified as etiological agents causing nosocomial infections. The number of strains of gram-negative coccidia equaled 215 (48.75%), gram-negative baccili equaled 210 (47.85%), fungi equaled 13 (2.95%), viruses equaled 2 (0.45%). Among the etiological agents that were isolated from materials obtained from patients with primary BSI the following agents prevailed: *S. aureus* 31 (34%), *S. epidermidis* 20 (22%), *S. hominis* 11 (12%) and others. In the cases of nosocomial pneumonia the following agents prevailed: *A. baumannii* 29 (32%), *S. aureus* 12 (13%), *E. coli* 11 (12%), and others. The following etiological agents were prevailing in the cases of urinary tract infections: *E. coli* 25 (40%), *P. aeruginosa* 9 (15%), *C. albicans* fungus 8 (13%) and others.

DISCUSSION

The incidence of HAI on the neurosurgical ward in the St. Lukas District Hospital was 3.86%. In the conducted studies, Göcmez et al. (5) observed that incidence of HAI associated with neurosurgery was 3.65%. According to the studies conducted as a part the Active Surveillance of Nosocomial Infections program, which is developed and coordinated by Polish Society of Hospital Infections, incidence of HAI on the surgical

Table VI. Urinary tract infections with incidence density (incidence density per 1000 catheter days) for urinary catheter associated infections on the neurosurgical ward from 2003 to 2012.

Incidence density - UTI with urinary catheter								
Year	Number of UTI	Number of UTI with urinary catheter	Number of urinary catheter days	Incidence density -* UTI with urinary catheter (‰)	UR ratio	Number of UTI without urinary catheter	Number of person-days without urinary catheter	Incidence density -* UTI without urinary catheter (‰)
2003	7	7	2347	2.98	0.28	0	6543	0
2004	5	4	2754	1.45	0.25	1	6689	0.15
2005	5	4	2687	1.49	0.24	1	6983	0.14
2006	8	5	2978	1.68	0.27	3	7234	0.41
2007	1	1	3245	0.31	0.27	0	7456	0
2008	4	4	3734	1.07	0.33	0	7710	0
2009	13	13	3848	3.38	0.37	0	6540	0
2010	10	10	3803	2.63	0.33	0	7862	0
2011	6	5	4187	1.19	0.36	3	7288	0.41
2012	15	12	4088	2.94	0.35	1	7796	0.13
Total	**74**	**65**	**33671**	**1.93**	**0.31**	**9**	**72101**	**0.12**

Incidence density*- incidence density rate per 1000 urinary catheter days, UR – urinary catheter utilization ratio

wards affected over 2% of patients and on the non-surgical wards even 4.56% of patients (6). In the study that involved 6,444 patients and that was conducted on the neurosurgical ward in Szczecin, Wieder-Huszla et al. (7) describes the occurrence of HAI in 128 (2%) patients. In our study HAI was diagnosed more often in the group of men 3.87% than in the group of women 2.22% and the obtained results were statistically significant. Experiences of other authors confirm the described dependencies (5, 7). Among etiological agents that we identified and that caused the diagnosed HAI cases, gram-positive microorganisms were detected most often comprising 48.75% of cases, among which the strains of *Staphylococcus aureus* constituted 69%. Gram-negative bacteria occurred relatively frequently constituting 48.75% of cases and among them the most frequent was *Acinetobacter Baumannie* 30%. The occurrence of particular species of microorganisms depended on the site of infection (6).

The analysis of collected data indicated that the most often recorded forms of HAI were SSI which was diagnosed in 140 patients and constituted 27.1% of all nosocomial infections on the studied neurosurgical ward. Cumulative incidence of SSI was 1.7%. Hover et al. (8) showed the incidence of SSI in neurosurgical operations at the level of 2.15%. Kim et al. (9) studied 2,803 surgical patients on the neurosurgical ward and they identified the incidence of SSI at the level of 2.62%. Among the etiological agents that were isolated on the studied neurosurgical ward from materials obtained from patients diagnosed with SSI the most common were *Staphylococcus aureus* (56%), *Acinetobacter baumannii* (14%), *Enterobacter cloacae* (7%) and others. Other etiological agents causing SSI were showed by Wieder-Huszla el al. (7).

The second group of HAI diagnosed on the neurosurgical ward are bloodstream infections. BSIs were diagnosed in 128 patients out of 13,352 patients hospitalized in the studied neurosurgical ward. Wójkowska-Mach el al. (10) presented the analysis of incidence of bloodstream infections. The analysis was conducted in 120 Polish hospitals where in the group of 513,807 patients the number of diagnosed BSI cases was 332.

In the studied neurosurgical ward pneumonia was the third most essential type of infections among patients with HAI. In Poland, it is assumed that 0.5 – 5% of all hospitalized patients get nosocomial pneumonia (17). Other authors also agree that nosocomial pneumonia is the third most common infection diagnosed in patients who underwent operations and the most common nosocomial infection in the intensive care units (18, 19). In the analyzed neurosurgical ward, in most cases nosocomial pneumonia was caused by the following microorganisms: *Acinetobacter baumannii* (32%), *Staphylococcus aureus* (13%) and others. The obtained results are consistent with reports presented by other authors (20, 21).

The fourth essential group of infected patients were patients diagnosed with urinary tract infections (UTI). UTIs were diagnosed in 74 (14.3%) patients and cumulative incidence rate was 0.58%. The obtained results were comparable with those presented in literature (22, 23). Among etiological agents that we identified and that caused UTIs the most common was *Escherichia coli* (40%). Many authors in their studies show identical microbial flora isolated in urinary tract infections in the area of neurosurgery (7, 24).

Apart from four basic forms of HAI, also gastrointestinal system infections (GI) were monitored. GIs were detected in 6.8% of hospitalized patients, cumulative incidence rate was 0.23%. In more than half of GI cases (51%) no etiological agent was isolated, in the remaining cases *Clostridium difficile* (23%) was the most common. According to the Bandoła et al. team, we can observe increased frequency of occurrence of these infections in the hospital environment (25). The last form of the discussed HAIs that were detected in the studied ward were skin and soft tissue infections (SST). The etiological agents of SST were most often *Staphylococcus aureus* (42%), and *Escherichia coli* (25%).

In the conducted studies about the incidence and structure of HAI during ten-year observation period, there was no significant trend of increase or decrease in the number of nosocomial infections. Incidence of HAI in specific forms such as: SSI, BSI, PN, UTI, GI and SST also remained at similar level over the years. Implemented prevention procedures, constant improvement of monitoring system and extending knowledge of medical staff allowed for the better detection of infections. The rules of surveillance and prevention of nosocomial infections in the studied ward were developed in 2001 and they concerned among others: hand hygiene, perioperative prevention, venous cannulation, urinary catheterization, dealing with the equipment for oxygen therapy. The used prevention procedures allowed for maintaining the nosocomial infections al the similar level for many years, with higher detection rate of infections.

SUMMARY AND CONCLUSIONS

1. Ten-year observation of infections detected in the neurosurgical ward shows that:
   a) HAIs were diagnosed in 3.86% of patients;
   b) The most common forms of HAIs were surgical site infections, bloodstream infections and pneumonia, some patients had more than one form of nosocomial infection;
   c) The most common etiological agent of HAI was *Staphylococcus aureus*.

2. The epidemiological situation in the studied neurosurgical ward did not significantly differ from the conditions in units with a similar profile.
3. HAI surveillance with epidemiological agents being taken into consideration is essential for the proper assessment of the incidence rate of nosocomial infections, their structure and identification of their source and determination of direction for taking or intensifying effective preventive actions.

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