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ALERT MICROORGANISMS ISOLATED FROM PATIENTS HOSPITALIZED IN MAŁOPOLSKIE PROVINCE IN 2010-2012

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ABSTRACT

OBJECTIVE. Healthcare centers undertake supervisory activities to control health care-associated infections (HCAIs) by elaborating procedures, identifying alert microorganisms and analyzing data collected. The aim of the study was to analyze the prevalence of alert microorganisms in hospital wards in 2010–2012.
MATERIAL AND METHODS. Legislation which is in force since several years introduced the principles of health care-associated infections control and reporting system. Analysis was based on annual reports on alert microorganisms provided by 19 District Sanitary and Epidemiological Stations from Małopolskie province. The data discuss positive tests results for alert microorganisms in patients who stayed in hospitals supervised by the Sanitary and Epidemiological Stations.
RESULTS. Compared to 2010–2011, the number of tests per hospital bed in 2012 was lower, amounting to 24 (2010 – 44, 2011 – 34). Of these tests, the majority was performed in the following wards: transplantology (2010 – 339, 2011 – 354, 2012 – 330), burn care (2010 – 354, 2011 – 148, 2012 – 113) and ICUs for adults (2010 – 155, 2011 – 157, 2012 – 140). In 2010–2012, an increase in the number of positive test results for extended-spectrum beta-lactamase-producing *Enterobacteriaceae (*ESBL+) and *Clostridium difficile* as well as slight decrease in the number of positive test results for other alert microorganisms were noted. The highest number of microorganisms was identified in neonatal and neonatal pathology (*Enterobacteriaceae* ESBL+); pediatric and infectious diseases (*Rotavirus*); infectious diseases (*Rotavirus*, *C.difficile*); burn care (*Acinetobacter baumanii, Pseudomonas* sp.) and ophthalmic and hemodialysis wards (MRSA).
CONCLUSION. Irrespective of a decrease in the number of tests per hospital bed in 2012, a high number of positive test results for alert microorganisms was observed. It suggests the necessity for wider application of collected data as to improve monitoring of infections and reduce resulting threats.

Key words: *alert microorganisms, hospital wards, health care-associated infections, microbiological test*

INTRODUCTION

Health care-associated infections (HCAIs) and antimicrobial therapy are one of the most serious concerns for modern medicine. Their prevalence is inseparably associated with treatment of patients in hospital settings. Therefore, total elimination of HCAIs is not feasible.

Activities undertaken within the surveillance aim at reducing the prevalence of infections by strengthening the supervision and efficacy of procedures applied. Surveillance over infections consists a constant, systematic collection of data, their analysis and interpretation based on standard scientific methods, including standardized infection definitions. The basic objective of surveillance is to identify etiological agents of HCAIs which consequently enables to determine the most prevalent microorganisms being the threat for both patient and hospital environment (1). Obligation to report HCAIs allows for early detection of epidemics and identification of single cases in high risk groups (2).

Executive documents in force issued by the Ministry of Health, regulating the principles of HCAI control, imposed the obligation of complex epidemiological surveillance in stationary health care centers, including adherence to preventive procedures based on current medical knowledge and monitoring of HCAIs associated with rendering of medical services. Act on Preventing and Combating Human Infections and Infectious

Diseases of 5th December 2008 (3) and regulations in force (4-7) introduced the principles of basic elements of control of HCAIs. They determine the composition of HCAI control team, the range of internal control over execution of activities set up, methods of reporting and the scope of reporting in case of suspicion or occurrence of infection within the routine evaluation of epidemiological situation in hospital.

System of data collection using HCAI records is based on standardized definitions, constituting reliable statistic tool and allowing for complex analysis of data. Methods which are applicable in Poland include passive and active reporting system. In case of passive system, reporting of cases and their recording belong to the responsibilities of medical personnel of a ward. Information is usually analyzed retrospectively, using hospital documentation and HCAI records. This method is hardly effective and detects ca 25% of all infections occurring in hospital. Active system consists in a daily, prior standardized qualification of infections by the members of HCAI team, with sensitivity of infection detection amounting to 95%. Therefore, systematic evaluation of infection incidence in a particular group of patients is feasible. Irrespective of the system adopted, collected data are a basis for developing recommendations and introducing modification into procedures applied in healthcare centers as to enhance the surveillance over patient colonization (8, 9).

So far, no one from Małopolskie province has published the results of analysis of alert microorganisms isolated from hospitalized patients with presentation of etiological agents.

This paper aimed at analyzing the prevalence of alert microorganisms isolated from hospitalized patients with regard to the specialization of hospital wards in Małopolskie province. It enabled to determine which alert microorganisms are highly prevalent and attract the attention of hospital personnel to the problem of patient colonization.

MATERIAL AND METHODS

Reports sent by 19 State District Sanitary Inspectors to the State Provincial Sanitary Inspector of Małopolskie province were subject to analysis. These annual reports included the data on the number of positive test results for alert microorganisms in patients hospitalized in Małopolskie province in 2010–2012.

The number of hospitals amounted to 72 (6,797 hospital beds), 70 (6,930) and 69 (6,838) in 2012, 2011 and 2010, respectively according to the register of healthcare centers of the governor of Małopolskie province. Alteration of the number of supervised centers resulted from organizational changes with the examples being: hospital mergers, occurrence of new hospitals or termination of hospital operation in a given territory.

Definition of HCAIs is pursuant to the Act of 5th December 2008 (3), which is analogical to the definition adopted by the World Health Organization (WHO). It is defined as: ”infection acquired during hospital care or associated with stay at hospital, which is secondary to the health status of a patient preceding hospitalization. It is with regard to both patient and medical personnel. It is an infection occurring more than 48 hours after patient admission to hospital, until 10 days following his discharge, until 30 days and a year following surgery and transplantation, respectively” (10, 3). A list of alert microorganisms which are monitored in healthcare centers was provided in the appendix 1 to the regulation of the Minister of Health (7). The following microorganisms were subject to analysis: methicyllin-resistant *Staphylococcus aureus* (MRSA), extended-spectrum beta-lactamase-producing *Enterobacteriaceae* (ESBL+), *Pseudomonas* sp., *Acinetobacter baumanii, Rotavirus* and *Clostridium difficile.*

In analysis the frequency of microbiological tests per hospital bed per year was discussed which enabled to evaluate the monitoring system of etiological agents of HCAIs.

RESULTS

In hospitals localized in Małopolskie province, an average number of microbiological tests per hospital

Table I. Number of microbiological tests per hospital bed per year in patients hospitalized in selected hospital wards in Małopolskie province in 2010–2012.

Ward	2010	2011	2012
ICU/IT for adults	155	157	140
ICU/IT for neonates and children	108	124	189
Surgical for adults	37	40	22
Orthopedic and traumatology	37	25	29
Non-surgical	37	38	27
Hematology and oncology	52	56	26
Obstetrics and gynecology	22	26	17
Neonatal	19	20	24
Neonatal pathology	40	65	75
Pediatric	46	41	35
Surgical for children	38	45	27
Psychiatric	8	6	0.8
Rehabilitation	2	2	1.3
Ophthalmic	20	30	15
Nursing/ geriatric / palliative care	3	4	6
Burn care	354	148	113
Infectious diseases	54	57	39
Transplantology	339	354	330
Hemodialysis	51	55	25
Other – beyond hospital structure	113	32	26
Total	33	34	24

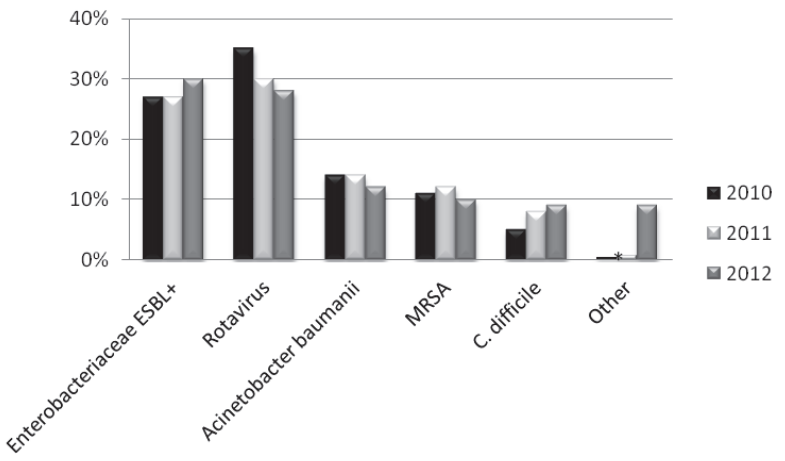

Fig. 1 Percentage contribution of alert microorganisms detected in hospitalized patients in Malopolska province hospitals, in years 2010–2012.
* Increase in 2012 is associated with including pathogens such as *Candida*, *Norovirus*, HBV, HCV, HIV

bed in 2012 amounted to 24, 34 and 33 in 2012, 2011 and 2010, respectively. Table 1 provides the number of tests with regard to the type of hospital wards.

Based on the analysis of percentage distribution of particular alert microorganisms with regard to a total number of positive test results of patients hospitalized in Małopolskie province, it was concluded that the most prevalent microorganisms in 2012 were *Enterobacteriaceae* ESBL+*, Rotavirus* and *Acinetobacter baumanii* (Fig. 1).

The highest percentage of alert microorganisms in 2010–2012 was determined in patients who were hospitalized in: intensive therapy/intensive care (IT/ICU) units for adults, non-surgical, surgical and pediatric wards (Fig. 2).

A detailed analysis of distribution of particular alert microorganisms isolated from hospitalized patients with regard to the specialization of wards in 2010–2012 was also performed (Tab. 2). The number of alert microorganisms isolated from these patients amounted to 8,154; 8,191 and 8,270 in 2010, 2011 and 2012, respectively.

Of the alert microorganisms identified in neonatal pathology, neonatal wards and ICUs for neonates and children in 2010–2012, the most prevalent were *Enterobacteriaceae* ESBL+. These microorganisms were not detected in ophthalmic and transplantology wards.

The highest distribution of rotaviruses with regard to positive test results was noted in wards where children were hospitalized – pediatric, infectious diseases and pediatric surgery wards. These microorganisms were rather not observed in wards where adults were hospitalized.

In all analyzed years, the highest distribution of *Acinetobacter baumanii* was observed in patients hospitalized in burn care wards and ICUs for adults. In 2012, these microorganisms were not identified in hemodi-

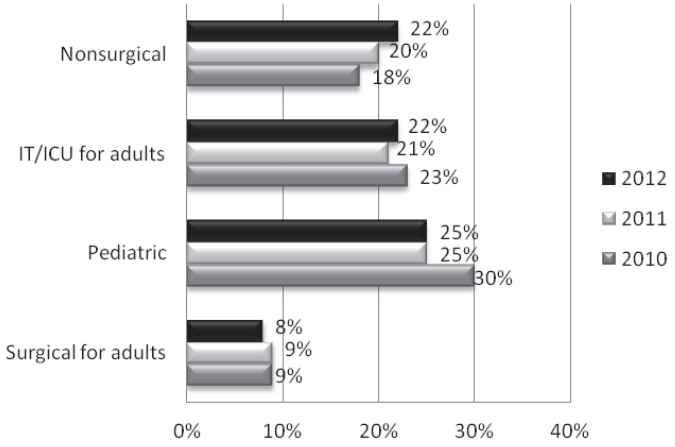

Fig.2 Percentage contribution of alert microorganisms most frequently detected in hospitalized patients in selected hospital wards in Malopolska, in period 2010–2012.
* percentage contribution of most frequently detected alert microorganisms in hospitalized patients in: ICU for adults, treatment/surgical wards for adults: *Acinetobacter baumanii, Enterobacteriaceae* ESBL+, *Pseudomonas* sp., MRSA, non-surgical: *Acinetobacter baumanii, Enterobacteriaceae* ESBL+, *C. difficile*, MRSA, pediatrics: *Enterobacteriaceae* ESBL+, *Pseudomonas* sp., *Rotavirus*, MRSA.

Table II. Distribution of alert microorganisms isolated from patients hospitalized in different wards in Małopolskie province 2010–2012.

ward	2010							2011							2012						
	Acinetobacter baumanii	*C. difficile*	*Enterobacteriaceae* ESBL+	*Pseudomonas* sp.	*Rotavirus*	MRSA	**TOTAL**	*Acinetobacter baumanii*	*C. difficile*	*Enterobacteriaceae* ESBL+	*Pseudomonas* sp.	*Rotavirus*	MRSA	**TOTAL**	*Acinetobacter baumanii*	*C. difficile*	*Enterobacteriaceae* ESBL+	*Pseudomonas* sp.	*Rotavirus*	MRSA	**TOTAL**
ICU/IT for adults	719	21	586	277	0	276	**1879**	631	22	552	289	0	272	**1766**	658	47	657	222	0	273	**1857**
ICU/IT for neonates and children	3	0	81	1	9	15	**109**	2	0	69	7	7	16	**101**	0	2	40	5	11	14	**72**
Surgical for adults	137	19	267	106	4	171	**704**	157	56	289	110	12	178	**802**	106	59	370	66	0	120	**721**
Orthopedic and traumatology	35	24	42	11	2	46	**160**	35	7	42	21	1	36	**142**	28	16	69	15	0	32	**160**
Non-surgical	234	199	772	163	12	252	**1632**	225	359	800	161	34	274	**1853**	207	414	962	115	23	235	**1956**
Hematology and oncology	3	12	34	4	32	5	**90**	7	29	20	9	16	6	**87**	6	15	52	4	26	10	**113**
Obstetrics and gynecology	2	0	47	5	2	15	**71**	1	3	55	3	1	15	**78**	3	7	59	1	2	10	**82**
Neonatal	4	0	33	3	0	11	**51**	0	0	44	1	1	9	**55**	1	0	85	2	0	12	**100**
Neonatal pathology	0	0	12	3	0	1	**16**	0	0	18	1	6	0	**25**	0	0	8	0	0	0	**8**
Pediatric	1	26	123	47	2224	63	**2484**	4	13	124	47	1837	47	**2072**	0	4	163	15	1880	33	**2095**
Surgical for children	0	1	26	1	60	6	**94**	0	0	11	1	36	8	**56**	1	1	13	1	32	6	**54**
Psychiatric	0	0	5	0	0	1	**6**	1	2	5	0	0	1	**9**	0	2	8	0	0	0	**10**
Rehabilitation	3	1	39	5	2	9	**59**	8	4	49	8	2	7	**78**	8	6	46	9	1	8	**78**
Ophthalmic	0	0	0	0	0	0	**0**	0	0	0	0	0	1	**1**	1	1	0	0	0	2	**4**
Nursing/ geriatric / palliative care	10	1	33	13	0	14	**71**	22	7	23	11	0	14	**77**	3	10	30	5	0	10	**58**
Burn care	16	0	2	3	0	3	**24**	13	0	2	1	1	0	**17**	24	0	8	7	0	4	**43**
Infectious diseases	9	89	51	6	470	23	**648**	7	108	58	16	455	32	**676**	5	180	59	7	537	22	**810**
Transplantology	0	0	1	0	3	0	**4**	0	3	0	0	3	0	**6**	0	0	0	0	0	0	**0**
Hemodialysis	0	2	12	0	0	8	**22**	0	4	5	1	0	5	**15**	0	0	2	0	0	3	**5**
Other – beyond hospital structure	1	0	11		12	6	**30**	0	36	18	4	209	8	**275**	7	1	25	2	0	9	**44**
TOTAL	**1177**	**395**	**2177**	**648**	**2832**	**925**	**8154**	**1113**	**653**	**2184**	**691**	**2621**	**929**	**8191**	**1058**	**765**	**2656**	**476**	**2512**	**803**	**8270**

alysis, transplantology, psychiatric, pediatric, neonatal pathology, anaesthetic and ICU wards.

In 2012, the highest prevalence of MRSA was identified in hemodialysis and ophthalmic wards while in 2011 only one case was detected in the latter. In 2012, these microorganisms were not detected in transplantology, psychiatric and neonatal pathology wards.

In 2010, the highest prevalence of *Pseudomonas* sp. was determined in burn care wards while this pathogen predominated in neonatal pathology wards and ICUs for adults in 2010 and 2011, respectively. These microorganisms were not detected in transplantology, ophthalmic, psychiatric and hemodialysis wards. In 2010, it was identified in neonatal pathology ward.

C. difficile was predominantly observed in ophthalmic, infectious diseases and non-surgical wards. These microorganisms were not identified in hemodialysis, transplantology, burn care, neonatal pathology as well as neonatal wards.

Of the alert microorganisms, *Enterobacteriaceae* ESBL+ and then *Rotavirus* (rotavirus was predominant in 2010–2011) and *Acinetobacter Baumanii* were predominantly observed in 2012. Compared to the previous years, the number of positive test results for *C. difficile* increased. As with the previous years, the highest number of alert microorganisms in 2012 occurred in pediatric, non-surgical wards, IT/ICUs for adults and then infectious diseases and surgical wards for adults.

DISCUSSION

Having considered the specialization of medical services and population of patients, the number of HCAIs and the type of occurring alert microorganisms is highly modifiable.

There is a lack of papers which would provide data on the prevalence of alert microorganisms in in-patient healthcare centers in particular provinces. Only little information may be found at sanitary and epidemiological station websites.

Compared to 2011 and 2010, an increase in the distribution of *Enterobacteriaceae* ESBL+ (*Klebsiella* sp., *Escherichia coli*, *Enterobacter* sp. with their respective share being: 30%, 27% and 27%), *Rotavirus* (28%, 26% and 35%) and *C. difficile* (9%, 8% and 5%) was observed in Małopolskie province in 2012. Similar increasing tendency with regard to the distribution of *Enterobacteriaceae* ESBL+ (24.6%, 16.8% and 17.3%) and *C. difficile* (6.6%, 2.2% and 2,2%) (11) was observed in these years in Wielkopolska province. One of the reasons which contributed to an increase of the positive test results for *Enterobacteriaceae* ESBL+ is a change introduced in 2012 to annual report, where the number of identified strains of *Enterobacteriaceae* ESBL+ was to be additionally provided. Compared to 2011 and 2010, the number of infections with *Acinetobacter baumanii* slightly decreased in Małopolskie province (12%, 14% and 14%, respectively). The percentage of patients infected with MRSA in 2012 was comparable in both provinces (ca 10%). Having analyzed crude cumulative data for 2010 and 2011, *Rotavirus*, *Enterobacteriaceae* ESBL+ and *Acinetobacter Baumannie* were predominantly identified as with 2009 (unpublished paper; Bandoła K. Analysis of annual reports on health care-associated infections and alert microorganisms in 2009 from healthcare centers in Małopolskie province, Provincial Sanitary and Epidemiological Station in Cracow 2010).

Studies conducted in France, Germany and Italy, included in WHO systematic review on the prevalence of endemic health care-associated infections (12) proved that out of 13,954 alert microorganisms, the most frequently notified microorganisms were MRSA (21.8%), *Enterobacteriaceae* ESBL+ (20.2%), *Pseudomonas* sp. (17.2%), *Enterococcus* sp. (10.0%), *E. coli*, (9.1%) and *Candida* sp. (8.8%).

In 2006–2007, the most frequently isolated microorganisms in 621 American hospitals were i.a. coagulase-negative staphylococci, MRSA, *Enterococcus* sp., *Candida* sp. and *E. coli* (13).

From the point-prevalence survey conducted in 62 German hospitals in 2012 transpires that the most commonly reported pathogen was MRSA (1.53%) (14). According to Polish available data, rotavirus predominated in pediatric and infectious diseases wards in Zachodniopomorskie province (25.8%) (15). These data are comparable to the data obtained in Małopolskie province (28%) and St. Luke's hospital in Tarnow, where the distribution of gastrointestinal infections, mainly those caused by *Rotavirus* with regard to all HCAIs amounted to 29.3% in 2011 (16). According to *Kuchar* et al., the exact number of HCAIs caused by rotaviruses is unknown in pediatric wards. However, they constitute a significant percentage of viral diarrheas (17). Based on the meta-analysis of 11 Polish studies, it was concluded that the frequency of infections with rotaviruses in population of hospitalized children was 0.72% while the percentage of gastrointestinal infections caused by these viruses amounted to 22.6% (18). According to *Ołdak* et al., the distribution of rotavirus infections with regard to all HCAIs in 2006–2009 was 31.4% (19). These data is similar to the results obtained in this paper. However, different percentages regarding the distribution of rotaviruses were obtained in Wielkopolskie province (31.6% – 2012, 41.13% – 2011, 38.5% – 2010) (5).

Frequency of rotavirus infections may be affected by many factors such as i.a. number of hospital beds

in wards (the higher the number of beds, the greater the risk of infection is), patient movements (between wards), hospitalization duration, season (increase of infections in winter season) as well as health status of medical personnel (20-22). Patient's age is also of importance. Infants aged less than 24 months belong to the highest risk group as they lack or have very poor immunity. Infections caused by rotaviruses constitute a high percentage of HCAIs (ranging from 23.8% to 43%). Since many years, this tendency remains stable in Poland (21) as well as in other European countries such as France, Germany, Italy, Spain or Great Britain, especially in population of hospitalized children (22). Therefore, the discrepancies in the prevalence of rotaviruses between provinces confirmed in this paper may result from the profile of hospitalized patients (age, health status), hospitalization duration and other factors such as organization of hospital operation (number of hospital beds in wards, patient movements etc.).

Comparison of the types of microorganisms cultured in particular wards in 2010–2012 enables to determine which pathogen is the most common in a particular ward. Furthermore, it facilitates to indicate microorganisms to which special attention should be paid. For instance, high distribution of *Enterobacteriaceae* ESBL+ strains in neonatal pathology wards as well as the increase of positive test results for *C. difficile* (8.6% of positive test results for alert microorganisms) should be the reasons for concern. Increased distribution of isolation of *C. difficile* in non-surgical and infectious diseases wards was also observed in Zachodniopomorskie province (5.5% in 2012) (15).

It is claimed that the spread of epidemic, hypervirulent strain belonging to genotype NAP1/BI/PCR-ribotype 027, which was identified in Poland for the first time in 2005, is attributed to the increase of incidence of diseases associated with *C. difficile* infections (23, 24). Having analyzed the data from the USA and Europe, it may be estimated that out of 30,000 and 10,000 hospitalizations annually, the number of intestinal infections caused by *C. difficile* range from 30 to 260 and from 10 to 90 cases, respectively (23). Having considered the results of the European study on *C. difficile* infections which was conducted in selected hospitals, it was concluded that the frequency of infections in Poland ranged from 3.8 to 36.3; 12.5 cases per 10,000 person-days and 76 per 10,000 hospital admissions on average (25).

The highest risk of infection occurrence is observed in ICUs (3%, 10.4% and 9.4% in 2004, 2005 and 2006, respectively) and wards in which invasive procedures are performed (biopsy, endoscopy, surgeries, long-term intravenous therapy), e.g. neurosurgery (2.5%, 1.8% and 1.9% in 2004, 2005 and 2006, respectively) or general surgery wards (1.2%, 1% and 1.5%) (26). These data are with regard to the years earlier than those analyzed in this paper, however, it suggests different distribution of infections compared to the frequency of positive test results for alert microorganisms, beginning from pediatric, surgical wards for adults, IT/ICUs and non-surgical wards. A special attention should be paid to the fact that already infected children are admitted to pediatric wards, e.g. with symptoms of rotavirus diarrhea. However, taking into account invasive procedures performed and group of patient with weakened immunological system, the highest risk of infection is indisputably observed in IT/ICUs.

Microbiological tests serve two basic functions: firstly, they enable to identify the type of infection in patients and initiate adequate treatment and secondly, they facilitate the control and prevention of HCAIs (27). Analysis of collected data suggests that adverse tendency of insufficient number of microbiological tests performed in hospitals is sustained. Furthermore, compared to 2011 and 2010, a significant decrease of this number (24, 34 and 33 tests per hospital bed in 2012, 2011 and 2010, respectively) was observed in 2012. The present number is two-fold lower compared to the value of the European standard (50 tests). Decreasing tendency is also observed in Wielkopolskie province (15, 19 and 19 tests/hospital bed/year) (15).

Indisputably, a positive phenomenon is that the number of tests is higher in wards where special regime of adherence to sanitary procedures is required. In Małopolskie province, the number of tests comparable to the European standard in 2012 was performed in neonatal pathology wards (75 tests). Higher number of tests was performed in IT/ICUs for adults (140 tests), IT/ICUs for neonates and children (180 tests), burn care (113 tests) and transplantology wards (330 tests).

Limitations of this paper result from the modifications introduced to the reporting system of the number of tests per hospital bed per year, including microbiological test except for serological tests which hinders complete analysis of alterations of the number of tests per hospital bed per year.

Nowadays, the data on the types of identified alert microorganisms and HCAIs are obtained within routine reporting system. In specialist literature, exclusively epidemiological data gathered within the programmes of the Polish Society of Hospital Infections may be found. However, this information is based only on the data from several dozens out of more than 700 hospitals operating in Poland. The National Programme of Antibiotic Protection, developed by the Ministry of Health, module "Monitoring of health care-associated infections and invasive bacterial diseases for epidemiological, therapeutic and prophylactic purposes" suggests an urgent necessity for introducing standards on monitoring of alert microorganisms based on the guidance and recommendations of WHO, Centers for

Disease Control and Prevention (CDC) and scientific associations such as the European Society for Clinical Microbiology and Infectious Diseases (ESCMID). Systematic reporting of alert microorganisms prevalence in hospital settings would allow for making complete assessment, comparisons between wards and hospitals as well as implementing effective methods of their elimination (28). It may be presumed that the order on the criteria of tender evaluation in proceedings of contracting medical services provisions issued in 2013 by the President of the National Health Fund would contribute to the improvement of monitoring system of alert microorganisms and HCAIs in the near future as one of the criteria is the assessment of HCAIs and antimicrobial therapy (29).

CONCLUSIONS

1. There is a lack of complex analyses and reports on health care-associated infections (HCAIs) detected in patients hospitalized in Małopolskie province. Such documents would improve monitoring system and could contribute to the reduction of infections.
2. It is a necessity to conduct further analyses on the frequency of alert microorganisms in the country. They could enhance the standards of monitoring and effective prevention of HCAI transmission.
3. In Małopolskie province, irrespective of the insufficient number of microbiological tests per hospital bed per year, a positive phenomenon is observed, i.e. an increase in the number of microbiological tests performed in wards of higher specialization.

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