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**Analiza nosicielstwa drobnoustrojów
wielolekoopornych wśród chorych przyjętych do
szpitala**

Carriage analysis of Multidrug-Resistant Microorganisms among
patients admitted to hospital

Rozprawa doktorska na stopień doktora
w dziedzinie nauk medycznych i nauk o zdrowiu
w dyscyplinie nauki o zdrowiu
przedkładana Radzie Dyscypliny Nauk o Zdrowiu
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4. Summary in English

Carriage of multidrug-resistant pathogenic microorganisms is a significant threat in the area of public health. It favors the transmission of alert pathogens in the hospital environment, increasing the risk of infection of hospitalized patients. Therefore, screening for MDRO carriers should become good practice in hospitals.

The program for analyzing the carriage of multidrug-resistant pathogenic microorganisms presented in this paper is one of the longest-lasting and most comprehensive, covering all potential groups of alert pathogens among the available test results described in the literature. As one of the few, the results of the analyses carried out, in accordance with the recommendations of SHEA / HICPAC (Society for Healthcare Epidemiology of America / Healthcare Infection Control Practices Advisory Committee), are presented using epidemiological indicators defining the number of carriers per 1,000 patient-days or per 100 hospitalizations.

The MDRO carriage research included adult patients admitted to a secondary hospital near Warsaw. At work, risk factors for MDRO carriage were: age over 60, stay in long-term care facilities, previous hospitalization in another hospital, hemodialysis, antibiotic therapy, or previous infection or colonization with alert pathogens. MDRO carriage was studied in six hospital wards, among which, due to their diversity, four groups were distinguished: general medicine wards (internal medicine ward, and neurology ward), surgical wards (general surgery ward, and trauma and orthopedic surgery ward), anesthesiology and intensive care ward, and an internal medicine and nephrology ward with a dialysis station. The diagnostic material consisted of swabs from the front wall of the nasal vestibule, from the skin in the armpit and from the anus, which were collected during the first 48 hours of hospitalization. During the implementation of the program, research and analysis was carried out on the carriage of gram-negative *Enterobacterales* producing extended-spectrum β -lactamases (ESBL), class A carbapenemases (KPC) or class B carbapenemases (MBL), gram-positive cocci

resistant to methicillin (MRSA) or vancomycin (VRE), and carbapenem-resistant gram-negative non-fermenting bacilli (CRAB, CRPsA).

The MDRO carriage analysis covered a period of 7 years (from January 1, 2012 to December 31, 2018). Tests were carried out on 11,025 adult patients, which constituted 19.25% of the population of patients hospitalized in the Wołomin hospital. In the course of the program, 2,925 (26.53%) MDRO carriers were diagnosed, and the indicator determining the number of carriers was 9.16/1000 patient-days and 5.16/100 hospitalizations. The fewest carriers (n=149) were diagnosed in the first year and the most (n=853) in the last year of the program.

A total of 20,701 screening tests were taken, including 8,851 nasal swabs, 852 axillary swabs, and 10,998 rectal swabs. The rate of screening utilization in the hospital was 17.48 tests/bed/year and 64.80 tests/1000 patient-days. The largest number of tests, 11,115, were taken in general medicine wards, and the least, 1,732, in surgical wards. The highest rates of utilization of screening tests were observed in the department of anaesthesiology and intensive care – 68.64 tests/bed/year and 261.47 tests/1000 patient-days. The lowest rates – 3.93 tests/bed/year and 21.32 tests/1000 patient-days, were found in surgical wards. The rates in the medical wards were similar to those observed in the whole hospital and amounted to 19.10 tests/bed/year and 58.97 tests/1000 patient-days. The test utilization rates in the department of internal medicine and nephrology with a dialysis station were similar to the values in the department of anesthesiology and intensive care, and amounted to 41.77 tests/bed/year and 128.42 tests/1000 patient-days. The 7-year analysis is in line with the recommendations given in the regulation of the Minister of Health of 2023 ^[106].

Carriage research included patients admitted to the hospital from the patient's home, from long-term care facilities, and from other medical entities in the Mazowieckie Voivodeship. It was found that the level of MDRO carriage in people admitted to the hospital directly from home was the lowest and amounted to 26.09%. A significantly higher percentage of MDRO carriage was observed in the groups of patients who, in the period preceding hospitalization, were residents of long-term care facilities (35.90%), or patients of other hospitals (39.18%).

More than half of MDRO carriers (51.14%) were diagnosed in general medical wards, and carriage rates were comparable to the values for the entire hospital and amounted to 7.93/1000 patient-days and 5.52/100 hospitalizations. The lowest percentage of carriage (9.85%) was identified in surgical wards, where only 3.66% of hospitalized patients were tested for MDRO carriage status. Carriage rates in this group of patients were the lowest and amounted to 3.55/1000 patient-days and 1.30/100 hospitalizations. The largest group included in the study (95.07% of the ward population) were patients of the anesthesiology and intensive care ward, where the highest carriage rates were found - 30.47/1000 patient-days and 24.37/100 hospitalizations. The department of internal medicine and nephrology with a dialysis station was ranked second both in terms of diagnosed carriers (27.52%) and carriage rates - 20.80/1000 patient-days and 12.11/100 hospitalizations.

In the course of the study, MDRO carriage status was diagnosed in 1,485 (50.77%) women and 1,440 (49.23%) men. There were no statistically significant differences between the two groups.

When analyzing the age of carriers, it was found that the largest group (2,454, or 83.90%) are carriers over 60 years of age, and the smallest group (471, or 16.10%) are people under 60 years of age. Most carriers (915, or 31.28%) were diagnosed at the age of 80-89, and the fewest (40, or 1.37%) below 30 years of age. Men constituted the dominant group among carriers up to 69 years of age, and women were the dominant group over 70 years of age.

Among the MDROs, 3,840 strains were identified, including: 1,189 (30.96%) *E.coli*, 1,119 (29.14%) *Klebsiella* spp., 946 (24.64%) *Enterococcus* spp. VRE, 421 (10.96%) *S.aureus* MRSA, 122 (3.18%) carbapenem-resistant *A.baumannii* and 43 (1.12%) carbapenem-resistant *P.aeruginosa*. Among *Enterobacterales* carriers the dominant group (51.52%) were *E.coli* carriers. In the group of carriers of gram-positive cocci, the dominant group (69.20%) were carriers of vancomycin-resistant enterococci, of which 97.99% were carriers of *E.faecium* VRE. Among the carriers of non-fermenting bacilli, the dominant group (73.94%) were carriers of *A.baumannii* CRAB.

In the general medical and surgical wards, as well as the department of internal medicine and nephrology with a dialysis station, the dominant group among *Enterobacterales* carriers were *E.coli* carriers (52.93%, 51.87% and 51.69%, respectively). *Klebsiella* spp. carriers dominated only in the anesthesiology and intensive care ward (55.77%). In all groups of wards, the dominant group among the carriers of gram-positive cocci were *Enterococcus* spp. VRE carriers (63.27% in the medical wards, 69.53% in the surgical wards, 68.28% in the anesthesiology and intensive care ward, and 80.05% in the internal medicine and nephrology ward with a dialysis station). In all wards, carriers of *A.baumannii* CRAB dominated among carriers of non-fermenting bacilli (65.33%, 89.66%, 86.84% and 60.87%, respectively).

For the analysis of MDRO carriage status, in addition to the standard number and percentage of carriers, epidemiological indicators were used. The highest number of carriers per 1000 patient-days and per 100 hospitalized patients was found in the group of *Enterobacterales* carriers – 7.22/1000 patient-days and 4.03/100 hospitalizations. The fewest carriers were observed in the group of carriers of non-fermenting bacilli – 0.52/1000 patient-days and 0.29/100 hospitalizations. The number of gram-positive cocci carriers was at a medium level and amounted to 4.28/1000 patient-days and 2.39/100 hospitalizations.

The occurrence of urinary tract infections (UTIs) was also analyzed during the implementation of the research programme. In total, UTI was diagnosed in 181 (8.74%) carriers of MDRO, with the women's group being about 1.5 times larger than the men's. The most common etiological factor of UTI diagnosed in MDRO carriers was *Enterobacterales*, diagnosed in 170 carriers (93.92%), including 93 (51.38%) *Klebsiella* spp. carriers, and 67 (37.02%) *E. coli* carriers.

Taking into account the prospective nature of the study, the long observation period, the large population of analyzed patients and the number of diagnosed carriers, it seems that the results presented in the paper truly define the epidemiological situation of MDRO carriers in a secondary hospital near Warsaw.