

COMPARATIVE STUDY OF THE INCIDENCES OF HOSPITAL INFECTIONS IN THE BURN DEPARTMENT: THE YEARS 2015 vs. 2022

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ABSTRACT

Introduction: Patients with burn injuries are particularly vulnerable to nosocomial infections due to the loss of the skin's protective barrier. Despite the improvement in the survival rates of burn patients in recent years, nosocomial infections are still a significant problem and are a significant threat to the treatment process.

Material and methods: A retrospective comparative cohort study was conducted. A comparative analysis was made of the medical records of patients hospitalized at the burn unit, hospitalized in 2015 and 2022, who had a nosocomial infection.

Results: In 2022, a statistically significant, higher percentage of patients with nosocomial infection was recorded compared to 2015 (chi-square (χ^2) = 11.635, $p < 0.05$). Both in 2015 and 2022, the dominant bacteria were Gram (-) *Acinetobacter baumannii*. In the case of bacteria (*Klebsiella pneumoniae*) a statistically significant decrease in infections caused by this pathogen was found in 2022 compared to 2015 ($\chi^2 = 4.3835$, $p < 0.05$). In 2015, the dominant Gram (+) bacteria were *Staphylococcus aureus* MRSA, while in 2022 a statistically significant decrease in infections with this strain was noted ($\chi^2 = 78.729$, $p < 0.05$). The dominant type of fungi in 2015 was *Candida albicans*, while in 2022 a statistically significant decrease in the proportion of this pathogen was recorded ($\chi^2 = 41.7053$, $p < 0.05$). In 2015, Gram (-) had the largest share in isolated pathogens, and in 2022 there was a significant decrease in their proportion in relation to the total ($\chi^2 = 14.301$, $p < 0.05$). In 2022 there was a statistically significant increase in the proportion of Gram (+) compared to 2015 ($\chi^2 = 21.185$, $p < 0.05$).

Conclusions: Nosocomial infections are still a significant problem in the treatment of patients after burn injury, and they require constant supervision and close control. Over the period of 7 years, there was a significant change in the dominant pathogens responsible for the occurrence of nosocomial infections in the burn units.

Key words: burn, nosocomial infections, infections.

INTRODUCTION

Burns are one of the most severe body injuries. Every year, 300-400 thousand inhabitants of Poland suffer from a burn injury, of which 70% are children [1].

In recent years, the survival rates of burn patients have improved significantly due to the intensive development of medicine and the operation of specialized burn treatment centres [2]. For a patient who has experienced a burn injury, a significant threat throughout the treatment process is the occurrence of infection during hospitalization. The conducted research reports that over the last 50 years, infections are the cause of 42-65% of deaths among burn victims. It should also be mentioned that infection in burnt patients is associated with 2-fold higher mortality compared to patients without signs of infection in

this group [3, 4]. The occurrence of nosocomial infection is predisposed by the loss of the protective barrier which is the skin, as well as the weakening of the immune mechanisms and the use of invasive therapeutic and diagnostic techniques. The biological conditions of the patient also influence the occurrence of nosocomial infections. The occurrence of infections also worsens the course of the burn disease, prolongs the stay, increases the complications, and increases the cost of treatment [5]. The assessment of the epidemiological status of a medical facility, measured by the percentage of nosocomial infections, is one of the indicators of the quality of medical care. The percentage of nosocomial infections illustrates the functioning of all hospitals, and they are a significant problem not only in medical terms but also financially [6]. Burn

wound infection is one of the most common complications in burn patients. According to the literature, the source of infection are patients with burns, staff, and medical equipment. The most common aetiological factors of burn wound infections are bacteria such as *Staphylococcus aureus* MRSA, *Acinetobacter baumannii*, or *Klebsiella pneumoniae* [4].

Patients with burn injury are a group of patients with impaired immunity, in whom pathogens and their toxins quickly enter the bloodstream, and thus quickly spread throughout the body, causing systemic changes affecting the development of multiple organs, and even their failure and death [4, 5]. The development of changes depends on the specificity of the pathogenic microorganism, the patient's age and general condition, the extent of the injury, and the presence of comorbidities. Wounds caused by burns require special epidemiological supervision and the introduction of prevention, which will allow for quick diagnosis and treatment of infection, as well as shortening the time of hospitalization and return to social life [7].

Nosocomial infections are inherent in medical facilities and affect most hospital wards [8]. During a review of the Polish literature, a significant deficit in the study of the occurrence of alarm microorganisms in specialist burn treatment centres was noted. Single studies on this subject are insufficient and require more in-depth study, which is why the presented results are important, and the fact that they refer to the perspective of change over the last 7 years additionally increases their value.

The study aimed to present an epidemiological analysis of a group of patients with burn injuries, hospitalized in Malopolska Burn and Plastic Surgery Centre of the Ludwik Rydygier Specialist Hospital in Cracow in 2015 and 2022.

MATERIAL AND METHODS

A retrospective comparative cohort study was conducted. Comparative analysis was carried out on the medical records of patients hospitalized in Malopolska Burn and Plastic Surgery Centre in the Burn Unit of the Ludwik Rydygier Specialist Hospital in Cracow hospitalized in 2015 and 2022. The study included all patients who suffered from a burn injury and in whom nosocomial infection occurred. Patients who did not develop a nosocomial infection during hospitalization were excluded from the study. The patients hospitalized in the burns ward stayed in isolation rooms with negative pressure and a supply of bacteriologically clean air. Each case of nosocomial infection diagnosis was based on the clinical, biochemical, and bacteriological diagnosis. At the same time, a hospital infection registration card was created, and

the collected information was stored in a database of a computer program. A hospital infection registration card was created. All collected information was stored in a database. The infection registration card was based on the information indicated in the Regulation of the Minister of Health of 23 December 2011, on the list of alarming factors [9], registers of nosocomial infections and alarm factors, and reports on the current epidemiological situation of the hospital. The epidemiological analysis was carried out based on data on the occurrence of pathogenic microorganisms from biological materials obtained from the microbiology laboratory and medical records. Reports of hospital infection cards, reports from the hospital Microbiology Department, and reports from the Centre for Hospital Infections were analysed.

This study was conducted in March 2023. To verify the research questions, the data collected in 2015 and 2022 were used for the analysis, using SPSS. The obtained material was subjected to statistical analysis using the chi-square (χ^2) independence test. Statistical hypotheses were verified at the significance level of $p < 0.05$.

RESULTS

In the analysed year 2015, in total in the Burn unit in Malopolska Burn and Plastic Surgery Centre of the Ludwik Rydygier Specialist Hospital in Cracow, 154 patients were hospitalized, and in 2022 a total of 160 patients were hospitalized. In 2022, a higher percentage of patients with nosocomial infection was recorded (33.8%, $n = 54$) compared to 2015 ($n = 35$, 22.7%). In 2015, in a group of 35 patients with burn injuries, 94 nosocomial infections were diagnosed. In 2022, 71 nosocomial infections were diagnosed in 54 patients with burn injuries. A χ^2 analysis was also carried out to check whether this percentage was higher in 2022 compared to 2015. It showed that there is a correlation between the year and the number of patients with nosocomial infection ($\chi^2 = 11.635$, $p < 0.05$). A higher percentage of patients with the infection was seen in 2022.

In 2022, the dominant biological material collected to identify pathogens in burn patients was venous blood (59.7%, $n = 470$), followed by arterial blood (11.2%, $n = 88$). The data are presented in Figure 1.

Below, in Figure 2, the percentage of identified pathogens is also presented in relation to the tests of biological material and medical equipment obtained from patients with burn injuries. The highest percentage of identification (100%), to test samples, was shown by the examination of fluid from the peritoneal cavity, pus, and urethral swabs.

In total, 385 identification attempts were carried out in 2022, during which the most frequently identi-

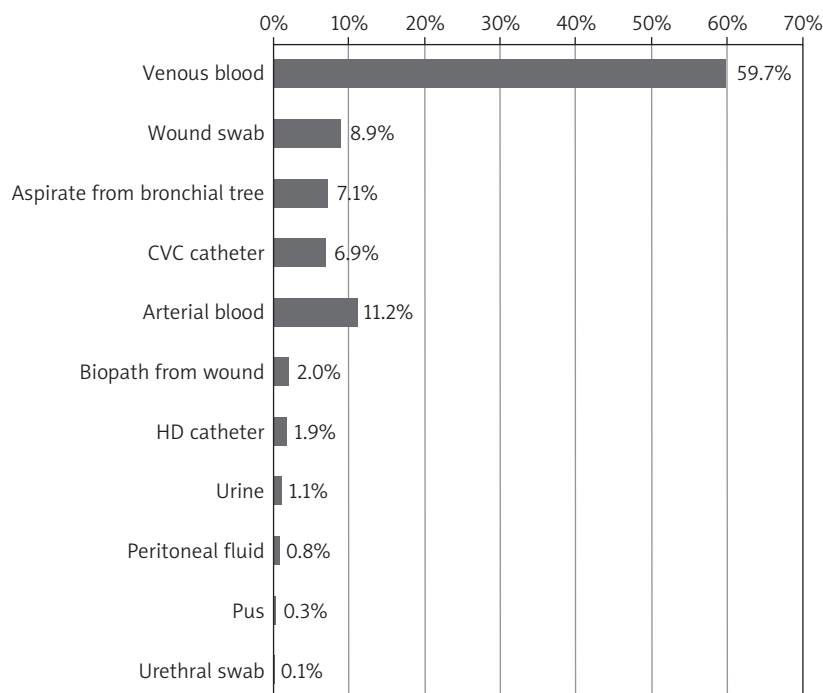


Figure 1. Biological material collected for the identification of pathogens in 2022 in the Burn Unit

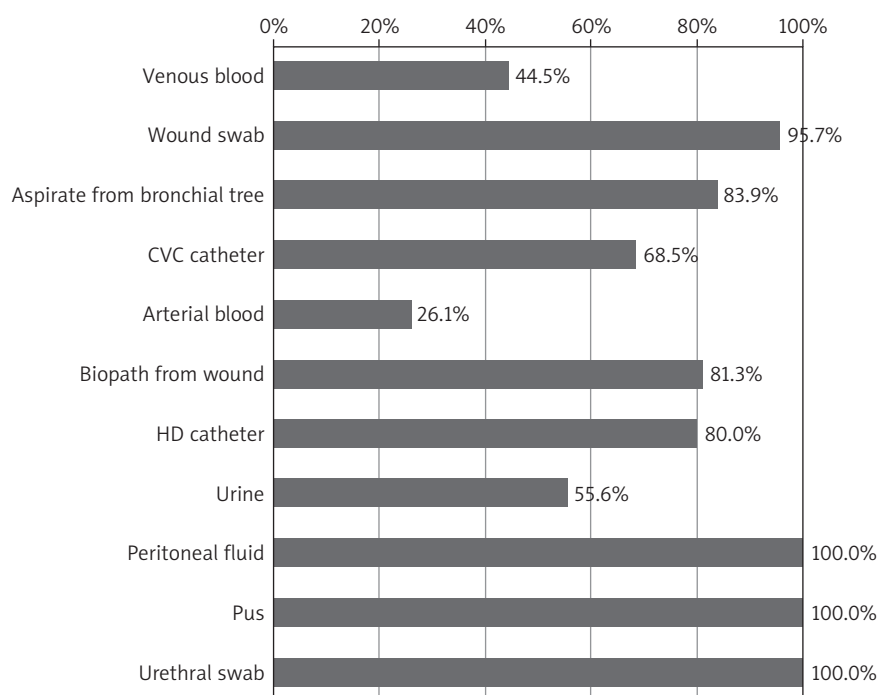


Figure 2. The number of identified microorganisms compared to the percentage of tests of biological material and medical equipment obtained from patients with burn injury in 2022 (n = 787)

fied microorganisms were: *Acinetobacter baumannii*, *Klebsiella pneumoniae* ssp. *pneumoniae*, and *Staphylococcus aureus*. Detailed data are presented in Figure 3.

The conducted analysis showed that both in 2015 and 2022 the dominant bacteria were Gram (-) *Acinetobacter baumannii*. These bacteria were present in

a similar percentage in patients hospitalized in 2015 (50.3%, n = 95) and in patients hospitalized in 2022 (56.5%, n = 96). Chi-square analysis showed no statistically significant relationship between the study period and the presence of this bacillus ($\chi^2 = 0.772$, $p > 0.05$). In the case of *Klebsiella pneumoniae* bacteria, there was a significant decrease in infections

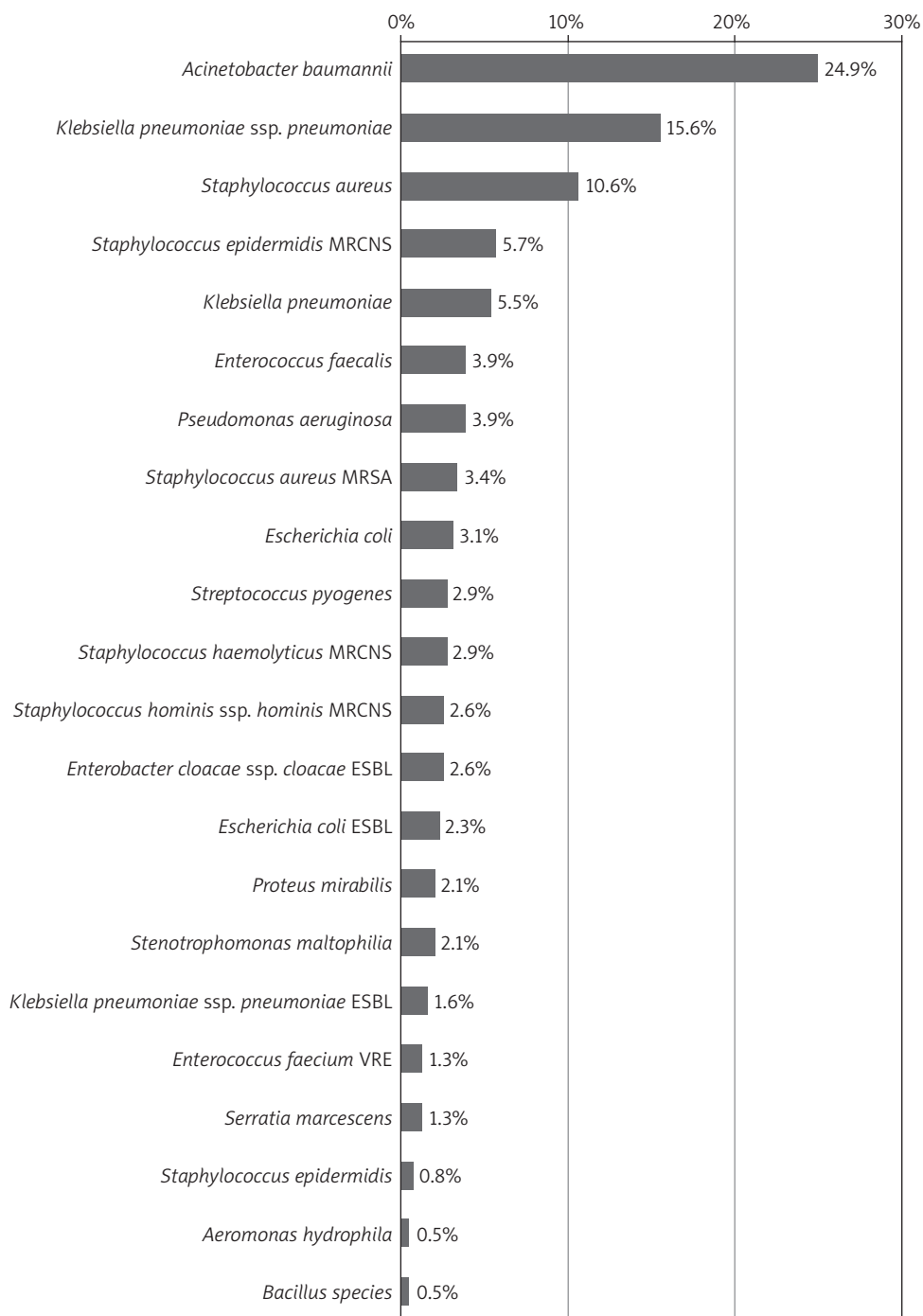


Figure 3. Structure of microorganisms identified in 2022 (n = 385)

caused by this pathogen from 23.8% (n = 45) in 2015 to 12.4% (n = 21) in 2022 ($\chi^2 = 4.3835, p < 0.05$). On the other hand, in 2022 there was a slight increase in nosocomial infections caused by patients with burns from the following G-bacteria: *Proteus mirabilis*, *Pseudomonas aeruginosa*, and *Stenotrophomonas maltophilia*. Isolated Gram (-) bacteria are shown in Figure 4.

The analysis showed that in 2015 the dominant Gram (+) bacteria were *Staphylococcus aureus* MRSA. It occurred in 69.6% (n = 16) of patients hospitalized in

2015 with a bacterial infection. In 2022, however, it decreased significantly to 8.4% (n = 13). The χ^2 analysis showed a statistically significant relationship between the study period and the occurrence of this species of bacteria ($\chi^2 = 78.729, p < 0.05$). In 2022, there was an increase in nosocomial infections caused by patients with burns caused by: *Staphylococcus epidermidis* MRCNS, *Enterococcus faecalis*, *Streptococcus pneumoniae*, and *Streptococcus pyogenes*. Isolated Gram (+) bacteria are shown in Figure 5.

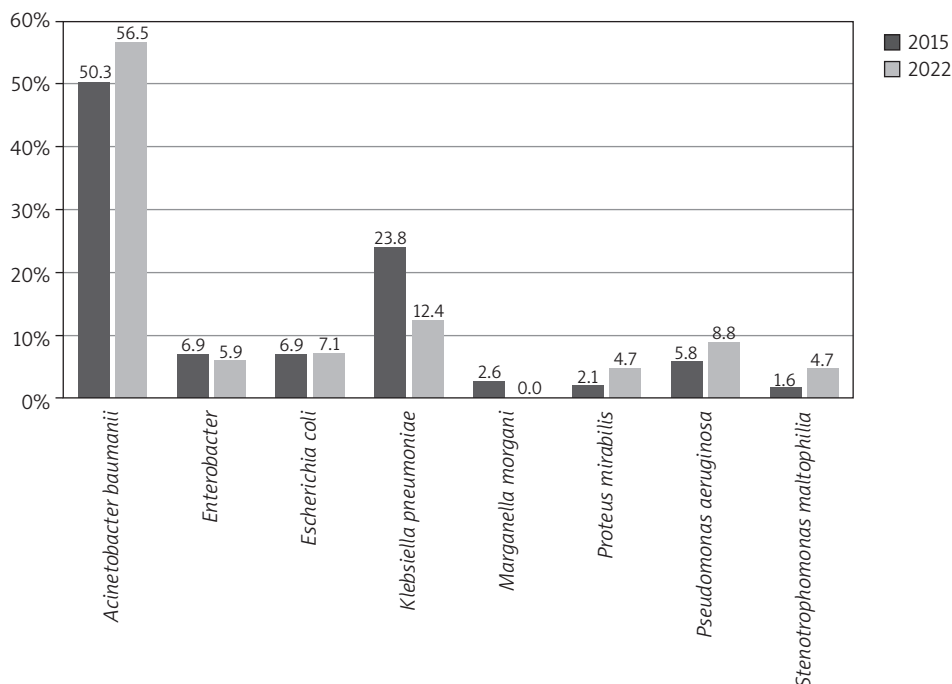


Figure 4. The most frequently isolated Gram (-) bacteria in 2015 (n = 198) and 2022 (n = 231) in the Burn Unit

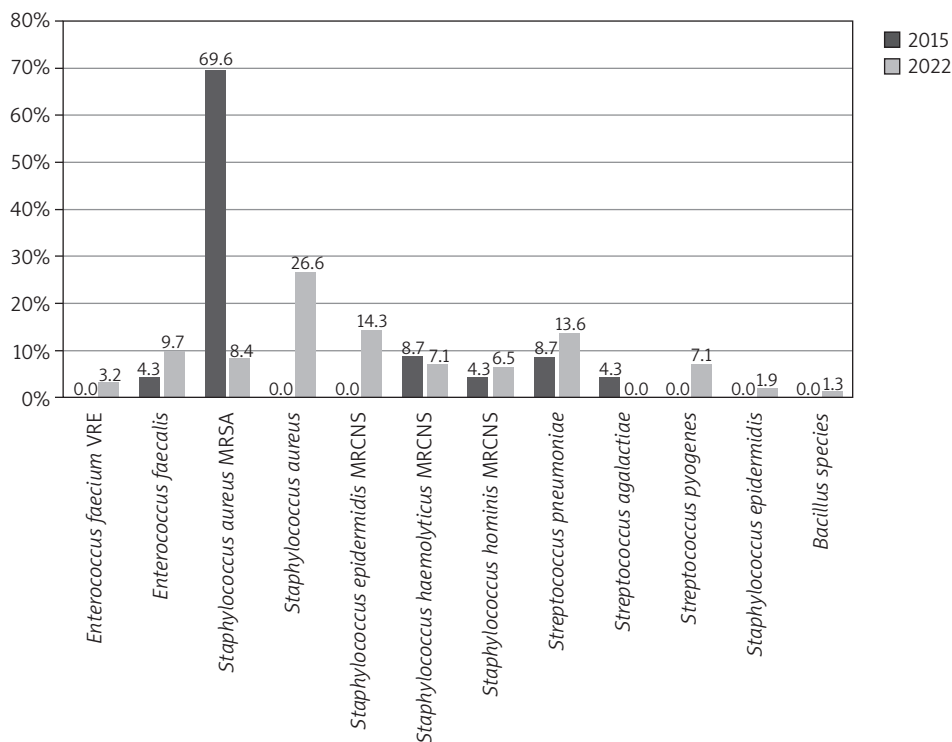


Figure 5. The most frequently isolated Gram (+) bacteria in 2015 (n = 23) and 2022 (n = 154) in the Burn Unit

In 2015, the dominant type of fungi isolated from the diagnostic material was *Candida albicans*, which was responsible for 81% (n = 17) of fungal infections in the burn unit. In 2022, a statistically significant decrease in the share of this pathogen was recorded to 36% (n = 9) ($\chi^2 = 41.7053, p < 0.05$). In turn, in 2022, an increase in infections caused by yeast-like fungi

from *Candida glabrata* was recorded, to 44% (n = 11), compared to 9.5% (n = 2) in 2015, so in 2022 a statistically significant increase was recorded ($\chi^2 = 26.1913, p < 0.05$). In 2022, there were also cases of infection caused by *Candida parapsilosis*.

A general breakdown of the structure of pathogens in 2015 and 2022 was also prepared, in which

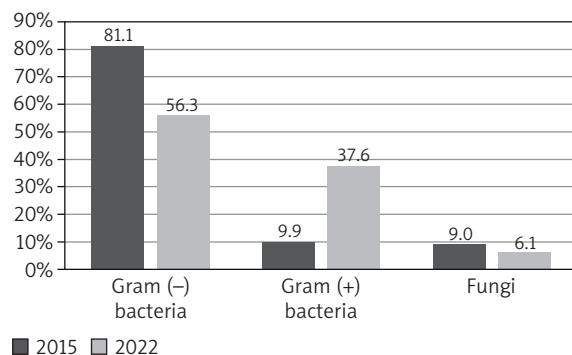


Figure 6. Structure of isolated microorganisms in 2015 ($n = 233$) and 2022 ($n = 410$) in the Burn Unit

the share of Gram (-), Gram (+) bacteria, and fungi is presented, which is shown in Figure 6. In 2015, Gram (-) bacteria had the largest share in isolated pathogens – 81.1% ($n = 189$). In 2022, there was a significant decrease in their share in relation to the total ($\chi^2 = 14.301$, $p < 0.05$). In turn, in 2022, the share of Gram (+) bacteria increased from 9.9% ($n = 23$) in 2015 to 37.6% ($n = 154$) in the analysed period ($\chi^2 = 21.185$, $p < 0.05$).

DISCUSSION

A burn is an injury that significantly reduces the immune system, both general and locally. In patients who have suffered a burn injury, there are many risk factors for nosocomial infection, which include loss of the protective barrier created by the skin, severe condition of the patient, metabolic disorders, invasive methods of treatment, and numerous surgical procedures [3, 4]. Despite the huge progress in the treatment of burn disease and the creation of isolation conditions for patients in the Malopolska Burn and Plastic Surgery Centre of the Ludwik Rydygier Specialist Hospital in Cracow, nosocomial infections are still a huge clinical problem and require constant supervision and control.

Preventing the occurrence of nosocomial infections is a dynamic process, conditioned by the currently dominant microorganisms, taking into account the adaptability of pathogens [5]. The analysis covered only the years 2015 and 2022, during which a total of 314 patients were hospitalized, and yet a total of 89 were diagnosed with nosocomial infection. This is a significant percentage of patients and confirms the thesis that the highest percentage of nosocomial infections is associated with hospitalization in intensive care, burns, internal medicine, haematology, and surgical wards [10-13]. In the burn ward, there was a worrying increase in nosocomial infections in 2022 compared to 2015. The analysis carried out showed a significant percentage increase in the number of infections, from 22.7% to 33.8%. The increasing number

of infections could be due to the severity of the burn injury, because the number of patient beds increased after 2019, following the construction and relocation of the burn unit to a new building constituting Malopolska Burn and Plastic Surgery Centre, where currently there are 6 stations in the Intensive Burn Therapy department. It should also be mentioned that the creation of a modern burn treatment centre and the increase in the number of patient beds increased the number of staff caring for patients. Malopolska Burn and Plastic Surgery Centre is also a training unit for students and doctors, which may also increase the risk of transmission of nosocomial infections.

The study showed that the most frequently collected diagnostic material to identify pathogens in burn patients was venous blood, followed by arterial blood. The results of the study also showed that the confirmation of infection was most often obtained with the collection of material from the fluid from the peritoneal cavity, pus, and urethral swab, while the blood test confirmed the infection only in 44.5% of the examined cases. This is due to the guidelines of the Surviving Sepsis Campaign 2021, which recommend taking blood for microbiological evaluation, and then other biological materials, depending on the suspected aetiology of the infection [14].

The literature shows that a very important epidemiological problem in the group of patients after burn injury is Gram (+) bacteria belonging to the *Staphylococcus aureus*, *S. aureus* methicillin-resistant, coagulase-negative staphylococci, *Enterococcus* spp., Vancomycin-resistant enterococci and Gram (-) strains *Pseudomonas aeruginosa*, *Escherichia coli*, *Klebsiella pneumoniae*, *Serratia marcescens*, *Enterobacter* spp., *Proteus* spp., and *Acinetobacter* spp. [15]. These indications were partially confirmed in the presented research results. Namely, in 2015, it was reported that the dominant Gram (+) bacterium was *Staphylococcus aureus* MRSA, which was detected in 69.6% of patients with nosocomial infection. While in 2022, there was a significant decrease in infection caused by this bacterium, which was detected in only 8.4% of patients with confirmed nosocomial infection. A significant impact on reducing the frequency of infections with this bacterium could have been the prophylaxis used in the burn ward. In the group of Gram (-) bacteria, both in 2015 and 2022, the most frequently isolated bacterium was *Acinetobacter baumannii*, which occurred in 50.3% of patients with nosocomial infections in 2015 and 56.5% in 2022. In 2022, there was also a slight increase in nosocomial infections, compared to the results from 2015, caused by the bacteria *Proteus mirabilis* and *Pseudomonas aeruginosa*. A similar analysis was performed on the burn unit at the Zhejiang University of Medicine Hospital in China in 2013, where it was shown that infections were

caused by Gram (+) bacteria *Staphylococcus aureus* (19.6%), *Acinetobacter baumannii* (11.9%), and *Pseudomonas aeruginosa* (11.9%) [16].

The literature reports that there are difficulties in the diagnosis of fungal infections in patients with burn wounds. Delayed identification of fungi causing nosocomial infection is associated with the problem of differentiating this type of infection from the early phase of bacterial infection [17]. Fungal infections in the Burns Departments in 2015 in burn patients accounted for 9% of all infections, while in 2022 they accounted for 6.1% of all hospital infections. The most important factors predisposing to fungal infections are long-term treatment with broad-spectrum antibiotics, reduced immunity, the presence of vascular catheters, and prolonged intubation. According to this study, the dominant species of fungi leading to nosocomial infection in 2015 was *Candida albicans*, responsible for 81% of all fungal infections. However, in 2022, a significant decrease in the identification of this species of fungus was noticed, to the level of 36% of all fungal infections.

Similar observations regarding fungal infections in the burn unit were observed in a study by Cen *et al.* at the Zhejiang University of Medicine Hospital in China in 2013, where fungal infections accounted for 11%; the dominant fungi leading to nosocomial infections were also *Candida albicans* [16]. There was also an upward trend in the share of fungi such as *Candida glabrata* in 2022, when they were responsible for 44% of all fungal infections. Comparatively, in 2015 they were responsible for only 9.5% of all fungal infections. This may be due to changes in antibiotic therapy over the years and changes in the composition of the microbiological environment of the unit.

According to the literature, in patients after a burn injury, colonization with more sensitive Gram (+) bacteria occurs most often in the first days, while in the subsequent days of hospitalization, Gram (–) bacteria are most often colonized. Fungal infections most often occur during long-term hospitalization. This fact has a significant impact on the choice of empirical antibiotic therapy [4]. These studies show that Gram (–) bacteria had the largest share in nosocomial infections in 2015, while in 2022 there was a significant decrease in their share in relation to all nosocomial infections. Also, it should be noted that the share of Gram (+) bacteria in nosocomial infections increased from 9.9% in 2015 to 37.6% in 2022. Fungal infections accounted for the following: 9% in 2015 and 6.1% in 2022. The situation involving an increase in infections caused by Gram (+) bacteria in 2022 may be associated with a greater number of short-term hospitalizations of patients, in relation to until 2015.

This study confirmed the legitimacy in terms of patient isolation, compliance with procedures, con-

tinuous epidemiological supervision, and the preparation of special conditions for the needs of the ward. The results of this study indicate that the percentage of patients with nosocomial infection in the Burn Department of the Malopolska Burn and Plastic Surgery Centre of the Ludwik Rydygier Specialist Hospital in Cracow is comparable to the results of other Intensive Care Units in Poland, where the level of nosocomial infections is at the level of 24-38% [18]. The severity of the patient's injury, the invasiveness of medical procedures, and the patient's endogenous flora remain the key factors influencing the incidence of hospitalization-related infections.

The increase in the number of infections from 22.7% in 2015 to 33.8% in 2022 proves that intensive surveillance of infections should be constantly carried out. This is a very important element and a challenge in quality management in medical facilities. The entire team caring for patients hospitalized in the burn unit should strive to reduce the rate of nosocomial infections. The changing bacterial and fungal flora of the ward may also be caused by population migration and difficult, changing working conditions during the SARS-CoV-2 pandemic [19]. The occurrence of multi-drug-resistant pathogens in burn treatment centres is also associated with the use of empirical antibiotic therapy focused on the treatment of multidrug-resistant pathogens, thus leading to increased resistance of pathogens to antibiotics.

Limited access to the 2022 data prevented a full comparison with the 2015 data. Moreover, the inability to include sociodemographic variables such as age or sex in the analysis, as well as other variables that may affect the incidence of infection, such as the degree of burns, comorbidities, length of hospitalisation, treatment given, or the presence of cannulas and catheters, points to the need for an in-depth analysis with their inclusion in future studies.

CONCLUSIONS

In 2022, more nosocomial infections were recorded in hospitalized burn patients in Malopolska Burn and Plastic Surgery Centre, in relation to the results from 2015. This shows that nosocomial infections in the group of burn patients are a significant clinical problem and require constant supervision and control.

The most frequently isolated microorganisms in 2022 were *Acinetobacter baumannii*, *Klebsiella pneumoniae* ssp., and *Staphylococcus aureus*. In 2022, the number of *Staphylococcus aureus* MRSA infections decreased compared to 2015, which may be related to the prophylaxis.

Both in 2015 and 2022, Gram (–) bacteria were most often isolated from biological materials. However, in 2022 a significant decrease in infections with bacteria from this group was observed, compared to

2015. In 2022, a statistically significant decrease in infections caused by *Candida albicans* was seen, in relation to 2015. An increase in infections caused by *Candida glabrata* fungus was noted.

Disclosure

The authors declare no conflict of interest.

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