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Urinary tract infections in seniors initiated by *Proteus* spp.

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Abstract

Background: Urinary tract infection is a bacterial infection of the urinary tract or kidneys. The most common affliction affects the elderly. Depending on the age, gender, and comorbidities, there are many factors that cause UTI. Urinary tract infection is a state when pathogens are found in the urinary tract. Diagnostics and treatment of UTI, despite highly developed medicine, are a problem for clinicians, because the beginning of infections are asymptomatic. In the later stages of the infection, symptoms may vary depending on the sex and age of the patient. The most common bacterium that causes UTI is *Escherichia coli*. However, a large number of men over 60 years of age are caused by *Proteus* spp.

Material and Methods: In this article the most up-to-date literature from the EBSCO and Google Scholar websites has been analyzed. Keyword used: Urinary tract infections, *Proteus* spp, elderly people.

Results: Bacteria of the genus *Proteus* spp are gram-negative uropathogens belonging to the Enterobacteriaceae family. They may cause different types of infections within the human body, however the most common of which is urinary tract infection (UTI). Older people are particularly exposed to urinary tract infections due to involutionary changes that begin to dominate in the human body after the age of 60, as well as many diseases and their complications that occur in this age group. In older men more often than women, the

pathogen responsible for this disease is *Proteus* spp. (Male gender slightly over 20% of cases, female gender - about 6%).

Conclusions: A relationship between urinary tract infection and the occurrence of other diseases such as diabetes, urolithiasis or obesity can be observed. The risk of infection increases also in hospitalized patients who undergo long-term instrumentation of the urinary tract. During the treatment of urinary tract infections the most important role is pharmacological treatment, i.e. antibiotics. A secondary, though still very important role fulfills a physiotherapy. Thanks to relaxation and breathing exercises, and pelvic floor muscle training physiotherapists can significantly improve the quality of life of geriatric patients with UTI.

Key words: urinary tract infections, *Proteus* spp, elderly people.

Introduction

Urinary tract infections are very common in elderly people as compared to other infections [1]. The most frequent etiologic factor of UTI is *Escherichia coli*. *Proteus* spp also contributes to this infection, because 20% of UTI is initiated by this uropathogen in men after 60 years old. The highest risk factors for Urinary tract infections are age, gender and coexistence of other chronic diseases. Elderly women are more often infected, because it comes from the anatomical structure of the urinary tract. Women after the age of 60 have an increased incidence of bladder decline and their estrogen concentration decreases, while in men over 60 the most common physiological anatomical-functional change is caused by diarrhea belonging to the Enterobacteriaceae family. The UTI is prostatic hypertrophy [2]. *Proteus* spp. are gram-negative bacteria belonging to the Enterobacteriaceae family [3].

Urinary Tract Infection (UTI)

We talk about urinary tract infections (UTI) when pathogens occur in the urinary tract as well as in the multiplication of pathogenic microorganisms. UTI are the most common, chronic and concurrent diseases with bacterial characteristics. Biofilms is undoubtedly an ideal place for the existence of microorganisms. The microorganisms that are found in the biological membrane have high sporulation abilities. They are resistant to antibiotics as well as other toxic substances that have degradation activities. Biofilms has the ability to protect the bacterial cell against defense tools of the host (weakness of non-specific immunity, phagocytosis). To understand the specificity of a biofilms, you need to become familiar with the process of creating this structure. There are five stages in which there are gradual changes in the genotype and phenotype of bacterial cells [4].

The first of these is adhesion or attachment of bacteria to a potential surface. They play an important role here intermolecular interactions van der Waals forces, hydrogen, ionic or temperature bonds. The hydrophobic capacity of the bacterial cell that is responsible for the polar hydrophobic groups of lipids in the outer or cellular membrane is important. The second stage is specific adhesion, the idea of which is the irreversible binding of the microbial cell to the target surface. It comes to the extracellular polymerase of bacterial cells. The third point is the creation of microcolony - the basic unit of biofilm. The next stage consists in the separation of bacterial microcolonies into a valuable biofilm and the synthesis of different proteins. The final stage separates single and large fragments of the bacterial cell. This results in the spread of biofilms [4].

It is said that more than half of bacterial infections are related to the formation of biofilms. The exception is not the UTI that affects humans most often. Urological pathogens, thanks to the ability to develop in the form of biofilms, can colonize the tissue of the macroorganism as well as deposit on urological catheters (polymerase with catheter

components, fe. propylene, silocon etc.). The risk of urinary tract infection is associated with the time of catheterization, while increasing by 5% each day. The infection is diagnosed in each patient if the catheterization time exceeds 28 days. Through the secretion that is made around the catheter in the urethra, microbes get into the bladder. Long-term catheterization causes a decrease in the quality of life, but it is a cause of health complications such as kidney inflammation, urolithiasis, and sepsis. A serious effect of long-term urinary tract drainage is the catheter incrustation. The cause is the urease produced by microorganisms. Urease hydrolyzes the solid urine component - urea to carbon dioxide and ammonium groups. This reaction precipitates calcium phosphate, magnesium ammonium phosphate and apatite carbonate crystals. The previously mentioned crystals and struvite contribute to the formation of urinary stones.

Salt crystals collect on the surface of the catheter, thereby obstructing the passage of urine from the catheter, bladder and kidneys, and may also cause urinary incontinence or painful bladder expansion. This problem affects almost 20% of the population [4].

UTI are the most frequently diagnosed kidney and urinary tract diseases. They constitute almost half of diagnosed nosocomial diseases and 10-20% of outpatient infections. The location of the urethra near the anus contributes to the frequent contact of the urinary tract with the intestinal microflora. The most vulnerable group are older people with anatomical-functional or long-term depraved defects [4].

Bacteria are the most common cause of urinary tract infections. The microbes occupy the urethra, bladder, ureters, and finally the kidneys. It also happens that the bacteria are sown in the blood. Among the factors that cause urinary tract infections are: Gram-negative representatives of the genus *Proteus*, especially species *P. mirabilis* and *P. vulgaris*. The last one is the most frequent etiologic factor of complicated UTIs, the second most frequent cause of the presence of bacteria in the urine associated with long-term catheterisation. Gram-positive bacteria (enterococci, staphylococcus or streptococcus) are much less likely to cause urinary tract infections. All groups of microorganisms associated with UTI have a tendency and conditions for growth in the form of biofilms, which contributes to the ability to penetrate microorganisms that are responsible for dangerous disease states as well as the reduced effectiveness of treatment [4].

Antibiotics have been the most common method of treating urinary tract infections for years. There are several types of antibiotics that neutralize uropathogens. In UTI, adults usually use fluoroquinolones - very effective compounds that affect most uropathogens. For resistant cases, antibiotics such as nitrofurantoin or fosfomycin are used. In the situation where the above antibiotics do not bring any effect, use drugs from the third group, eg cefixime, cefopodoxime. Recurrent urinary tract infections are an indication for therapy lasting on average from a few weeks to several months. Administration of small doses of antibiotics every day or every other day for the night [4].

Based on bacteriological examinations of urine carried out in 2006-2013 in people over 60 years of age, a study was conducted to "evaluate the etiological factors of bacterial urinary tract infections occurring in geriatric patients hospitalized in non-surgical departments of the hospital of the Ministry of Interior in Białystok (...) this range between men and women. " Urine samples were taken from patients from the midstream stream, or from a new Foley catheter. Detected species were divided into two groups of pathogens:

- * Gram-negative: in which the presence of *Proteus* spp. Was specified (*P. vulgaris*, *P. mirabilis*, *P. penneri*)

- * Gram-positive. The research showed that the UTI was burdened in particular with patients of the Geriatrics Department as opposed to people from the Department of Cardiology and the Department of Internal Diseases. Gram-negative bacteria contributed to 87.2% of UTI cases in women and 77.1% of UTI in men. Research has also proved that *Proteus* spp. much

more often appeared in men than in women (20.6% to 6.3%). Interpreting the whole study, one can notice large differences in the etiopathogenesis of UTI between sex groups in the geriatric group [3].

Proteus spp - characteristic

Bacteria of the genus *Proteus* spp are gram-negative uropathogens belonging to the Enterobacteriaceae family. Initially, *Proteus* spp formed only *P. mirabilis* and *P. vulgaris*. Currently it includes 5 species, i.e. *P. mirabilis*, *P. vulgaris*, *P. penneri*, *P. hauseri*, and *P. mixofaciens* [5]. These pathogens, with the exception of *P. mixofaciens*, are conditionally pathogenic, i.e. they cause different types of infections within the body. However, the most common of them is urinary tract infection (UTI).

Bacteria from the genus *Proteus* spp. have evolved for many centuries, which are responsible for the conditioning of their pathogenicity, i.e. adherence, which is associated with the presence of fimbriae or afimbrial adhesins, invasiveness, haemolytic activity, endotoxin production and urea decomposition. Uropathogens from the genus *Proteus* spp. are known for their proteolytic properties, or the ability to oxidatively deaminate amino acids under relatively anaerobic and aerobic conditions, and hydrolysis of urea to NH_4 and CO_2 . Thanks to ureming, they can move relatively quickly, which may contribute to the widening of the infection. Cilia being a strong H-antigen, stimulate the immune system to a humoral response [6]. They are responsible for the production of proteases and ureases that increase the pH of urine.

In addition, *Proteus* spp is characterized by a dimorphism that is associated with the environment. This means that when growing on the liquid substrate, they appear as short, rarely devoured cells. However, when growing on a solid substrate, they transform into long, densely ciliated cells. Swarmer cells move on the substrate until the bacteria "disperse" and then break down cyclically into short sticks. Migrations of swarmer cells are favored by surface polysaccharide called cmf. It is also believed that putrescine together with CPS molecules is responsible for the start of bacterial differentiation. If the nutrients are devoid of glutamine, then there will be no rapid growth. Uropathogens *Proteus* spp produce haemolysins, those associated with the cell - HpmA in each species of the genus and extracellular - HlyA in the strains *P. vulgaris* and *P. penneri* [7].

In *Proteus* spp as gram-negative bacteria, the most frequently negatively charged polysaccharides have a special role in biofilm formation, which contain uronic, phosphate or sulphate acids responsible for creating glycocalyx. Their individual molecules are cross-linked by magnesium or calcium cations [8].

As a natural environment, bacteria of the genus *Proteus* spp are considered polluted waters, soil, natural fertilizer, and also constitute the physiological flora of the digestive tract of humans and animals. *Proteus* rods are opportunistic pathogens, which in favorable conditions cause respiratory tract infections, wounds, bones, gastrointestinal tracts, or in hospital or nursing homes of the elderly, arthritis and meningitis and urinary tract infections, which most often occur. Hospital infections constitute 2/3 of all infections, and *P. mirabilis* [9] is considered the most important etiologic factor of infections, which, according to epidemiological studies, accounts for 5% of all nosocomial infections.

Epidemiology of Urinary Tract Infections

Urinary tract infections are still an important problem, that affects many people. The incidence of this type of infection varies depending on the age, sex and health status of the particular patient [10].

In the childhood, urinary tract infection may affect up to 8% of the population of this group of people. In the first quarter of a child's life, boys are more exposed to urinary tract

infection, due to the more common congenital urinary tract malformations. In later periods of life, urinary tract infections are more often found in girls, which results from their anatomical structure, e.g. shorter urethra than in men. During puberty, the problem of urinary tract infections is also present. This is caused by, for example, early sexual activity by young people. Infections of the urinary tract in children are usually caused by a bacterial infection and may result from the presence of Gram-negative and Gram-positive bacteria, however, with a significant advantage of the first of these groups. The most frequently identified pathogen in young people with urinary tract infection is *Escherichia Coli* (responsible for over 60% of infections) and bacteria of the genus *Klebsiella*, as well as *Proteus mirabilis*. An important issue is also the fact that up to 30% of children recur in the course of a year [11].

The second group of people who are particularly exposed to urinary tract infections are older people. This is due to involutionary changes that begin to dominate in the human body after the age of 60, as well as many diseases and their complications that occur in this age group. Urgent urinary tract infections more often affect geriatric women than men. Studies show that Gram-negative and Gram-positive infections are also dominant in this age group, both in men and women. The most common pathogen found in both sexes is *Escherichia coli*. An important issue is the fact that in older men more often than women, the pathogen responsible for this disease is *Proteus* spp. (Male gender slightly over 20% of cases, female gender - about 6%). An important issue is also the fact that urinary tract infections are very common in hospitalized people, which is a serious threat to the elderly with immunodeficiency, prolongs treatment and convalescence, and heightens the expenses and costs of such people's treatment. For example, people with diabetes develop asymptomatic bacteriuria more often, and if left untreated, lead to kidney failure, which is a serious threat to the patient's health and life [3, 12].

Stroke is the cause of disability and death of many people in the world. One of the complications of this disease are urinary tract infections, which lead to further disorders and delay the rehabilitation of patients. Studies indicate that the cause of such a situation is largely associated with the presence of a urinary catheter established permanently as a result of the lack of control in passing urine by the patient. This predisposes to the development of bacteria, and the probability of infection in a deputy person for more than 30 days reaches almost 100%. In addition, the development of urinary tract infections is facilitated by immobility and low fluid supply [13].

Infections of the system can occur at any age and often recur in a short time, therefore people exposed to this disease deserve special care and support [13].

Etiology of urinary tract infection in geriatric patients

In people of geriatric age, urinary tract infection is one of the most common bacterial infections that these people have to deal with. Statistics show that they represent a significant percentage of all infections, especially if hospital-acquired infections are isolated. Pathogens attacking the urinary system, get there through the ascending path (where the bacteria attack successively the urethra, bladder, ureters, and finally the kidneys), lymphopathogenesis and blood-borne [3]. If the body is in a state of relative health, thanks to various mechanisms it is able to protect itself from them and to produce sterile urine. However, if these mechanisms fail, for example as a result of invasive procedures or sexual intercourse, microorganisms equipped with virulence factors may enter the body, which in turn leads to the expansion of infection [4, 14].

Bacteria are by far the most common factors leading to urinary tract infection. Among them, Gram-negative rods from the Enterobacteriaceae family dominate. The most frequently isolated uropathogen is the colon bacillus, the next most frequently occurring bacteria are representatives of the genus *Proteus* (for example *Proteus mirabilis* and *Proteus vulgaris*). In

the etiology of this disease, viruses, protozoa, fungi or parasites are much less frequently found [4, 15].

In many studies, there is a correlation between urinary tract infection and the occurrence of diseases such as diabetes, urolithiasis and obesity. The risk of fighting infections increases in hospitalized patients who undergo long-term instrumentation of the urinary tract and in people using drugs such as cholinolytics, calcium channel blockers or glucocorticoids. All the above-mentioned factors are relatively common in geriatric patients [3, 16].

One of the factors that negatively affects the number of incidences of urinary tract infections is the anatomy of the urogenital system of the human and changes in it under the influence of aging. The position of the anus near the mouth of the urethra causes the intestinal microflora to be able to attack the urinary system in a relatively easy way [1]. Women are more often exposed to urinary tract infections, mainly due to shorter urethra than men, which translates into easier access of uropathogens, for example after sexual contact. Other common risk factors for urinary tract infection include:

- bladder reduction and associated urinary stasis
- vaginal influenza
- narrowing of the urethra
- postmenopausal reduction of estrogen
- reduction of lactobacilli [3, 1, 17].

In men, with age, the main problem is prostatic hypertrophy, which causes the symptoms of narrowing the urinary outflow from the bladder. The volume of urine deposited after the micturition also significantly increases, which results in easier colonization of the urinary system together with the prostate by bacteria. The fight against pathogens is not easy due to the poor local response of antibiotics and the formation of osteoarthritis, which often is the focus of the next infection [4, 18].

Diagnostics and abnormalities *Proteus* spp.

Correct diagnosis of infection is the foundation for proper treatment. The most commonly used pathogen identification method is the assessment of the ability to carry out biochemical reactions [19]. *Proteus* rods form a biofilm in the urinary tract. The biofilm formed by it consists mainly of apatite and struvite crystals that form the urinary stone, and over time can cause impeded urine flow or completely block the lumen of the catheter introduced into the bladder. The main goal in the diagnosis of infections of *Proteus* spp. is the rapid detection of biofilm, which is willingly formed on foreign bodies introduced into the body. One of the main methods of detection of *Proteus* in the material under study is the Richard method, which allows to assess the ability of pathogens to convert 2,3,5-triphenylphthalazolium chloride into red triphenylformazane [20].

Another method of diagnosis for the presence of bacteria in the Enterobacteriaceae family is the cultivation of bacteria on an agar medium with the addition of esculin. The above method will not confirm the presence of *Proteus* spp., and it will be excluded, because *Proteus* spp. bacteria do not have the ability to hydrolyze esculin [19].

The bacteria *Proteus* spp. in recent years show an increasing resistance to antibiotics, which forces changes in the treatment used so far. Increased resistance to antimicrobial agents complicates the treatment and leads to an increase in the mortality rate among patients [21]. Resistance was observed among many groups of antibiotics, including β -lactams, tetracyclines, sulfonamides, fluoroquinolones, nitrofurantoin, fosfomycin and aminoglycosides. Among the antimicrobials from the β -lactam group, bacteria are resistant to both penicillins and cephalosporins [21,22].

Prevention of urinary tract infections (UTI) caused by *Proteus* spp.

The high risk groups of urinary tract infection are: the elderly people, patients with anatomical or physiological defects of the urinary tract, patients hospitalized, long-term catheter patients [4], immunodeficient or diabetic patients and pregnant women.

It is estimated that over 60% of bacterial infections are associated with the phenomenon of biofilm formation [23]. Biofilm is an extremely beneficial for bacteria environment, which protects them against toxic, germicidal and immune mechanisms of the host organism [4]. An important stage in the creation of the biofilm is the adhesion of bacterial colonies to the substrate, which is why urological catheters made of materials such as propylene, polystyrene, silicone, polyvinyl chloride or silicone latex significantly increase the likelihood of UTI [4]. Prevention of urinary tract infections in patients undergoing catheterization is mainly related to preventive measures. Observing the aseptic technique when introducing a catheter into the urinary tract, or frequent replacement of catheters are standard methods of prevention prior to infection [4]. Attempts to use bactericidal ointments in the area of the urethral or antiseptic mouth turned out to be ineffective in reducing the risk of UTI [4]. The risk of urinary tract infection is closely related to the duration of the catheterization, the type of catheter used and the type of material from which it was made. Catheters made of latex are much more susceptible to bacterial adherence and biofilm formation than their silicone counterparts, and also with long-term urinary tract drainage they cause bladder inflammation [24]. There are also attempts to cover the interior of urological catheters with active pharmaceutical substances, such as: polyvinylpyrrolidone (PVP) [25], iodine complex with polyvinylpyrrolidone (PVP-I) [26] or phosphorylcholine, which applied on the surface of urological stents, significantly limits bacterial adherence [4]. Urological catheters covered with heparin were also examined, in which, after 6 weeks of application, no bacterial conglomerates or incrustations within the applied biomaterial were found [27]. Also, covering the catheters with a layer of nitrofurazone, and with silver oxide or alloys of this metal, in many cases resulted in a significant decrease in the number of infections and bacteriology [28, 29].

The influence of physiotherapy on UTI.

Patients with urinary tract infections can often complain of lower back pain in both the central part of the back and laterally, therefore a physiotherapeutic examination and an in-depth interview are the basis, because the actual patient's problem may differ significantly from the one that goes to the physiotherapist. It should also be remembered that among elderly people, UTI is usually associated with other diseases related to diabetes, hypertension, prostate obstruction or kidney stones. In the process of rehabilitation of these people it is very important to take into account the above-mentioned diseases, which may be contraindications for therapy [30].

Specialists in the field of pelvic floor dysfunction can effectively improve the quality of life of geriatric patients with UTI. An important element of treatment in this type of diseases is pelvic floor muscle training, manipulations, breathing and relaxation exercises as well as reeducation of muscle coordination [31].

Physiotherapists increasingly, together with the rest of the staff, try to educate the patient in the matter of taking adequate amounts of fluids and adherence to therapeutic recommendations in order to improve the effectiveness of the therapy in which the entire medical team participates [32]. Education and work with a physiotherapist significantly affect the effective emptying of the bladder and full relaxation of the pelvic floor muscles during excretion [31].

All these activities can also be included in the prevention of UTI. The studies also showed a beneficial effect of mobilization in the treatment of patients with a catheter and proved that it is completely safe [33].

The pelvic floor is composed of two types of fibers, 70% of them are oxidative fibers, and 30% are glycolytic, responsible for quick and strong contractions. Pelvic floor training involves regular and, what is important, conscious tensioning and loosening of these muscles. It is recommended to do exercises in three series of 8-12 repetitions. It is based on maximum muscle tension and maintaining this state for 6-8 seconds [34,35].

Frequency should be 3-4 times a week. The essence of these exercises is to teach you to tighten and loosen only specific muscles without running the abdominal compressor, which can be achieved thanks to the appropriate starting position used in the exercise [36,37]. It should be remembered that physiotherapy is one of the elements in therapy, it plays a more important role in preventing the disease and recurring urinary tract infections.

Conclusions

UTI are one of the most common diseases occurring in older people. They are more often seen in geriatric women because they have a shorter urethra, which contributes to the progression of infection. On the other hand, it is often caused by *Proteus* spp in ZUM men. The most frequent etiologic factor is *Escherichia coli* and *Proteus* spp. In the etiology of this disease, viruses, protozoa, fungi or parasites are much less common. However, the most important risk factors are age, sex or the occurrence of other chronic diseases. In addition, in many clinical trials, there is a correlation between UTI and the occurrence of diseases such as diabetes, urolithiasis and obesity. The risk of infection increases in hospitalized patients as well as in people using cholinolytic drugs, calcium channel block or glucocorticoids, which is relatively common in geriatric patients.

It is recognized that over 60% of infections are related to the phenomenon of biofilm. Biofilm is considered to be the best place for bacterial growth, because it protects the bacterial cell against host defense tools. Biofilms are spread by separating single and large fragments of a bacterial cell. *Proteus* spp due to its ability to develop in the form of biofilms can create colonies on the tissues of the macroorganism and deposit on urological catheters through polymerase with components of the catheter. UTI are diagnosed in every patient whose catheterization time exceeds 28 days. Through the action that arises around the catheter, the microbes get into the bladder. The result of a long-lasting catheter is its incrustation. Urease hydrolyzes urea to CO₂ and NH₄ groups, which causes the precipitation of Ca₃ (PO₄)₂, (NH₄)₃PO₄, Mg₃ (PO₄)₂ and apatite carbonate crystals, which contribute to the formation of urinary stones. Salt crystals accumulate on the surface of the catheter which causes impeded flow of urine, resulting in incontinence or painful expansion of the bladder.

The most commonly used antibiotics in UTI are fluoroquinolones, nitrofurantoin or fosfomycins. Recurrent UTI are indications for long-term treatment, lasting from several weeks to even several months.

Proteus spp uropathogens are gram negative bacterias that can move relatively fast due to cilia, which can lead to the spread of infection. They increase the urinary pH, are characterized by dimorphism, invasiveness or hemolytic activity. Their natural environment is polluted water, soil, natural fertilizer or digestive tract of people and animals. Under favorable conditions, they cause respiratory tract infections, wounds, bones, gastrointestinal tract, arthritis and cerebrospinal meningitis or the above-mentioned UTI, which occurs most frequently. Hospital infections constitute as much as 2/3 of all infections, and the most important aetiological factor of UTI is *P. mirabilis*, which stands for 5% of all nosocomial infections.

UTI are also one of the complications of stroke, which leads to further disorders and delays rehabilitation of hospitalized patients. This is caused by permanent catheterization as a result of lack of control during urination by the patient. This factor predisposes to the growth of bacteria, and the probability of infection increases after 28 days to almost 100%. In addition, the development of urinary tract infections is facilitated by immobility or inadequate fluid delivery to the body. Correct diagnosis of UTI is the basis for appropriate treatment. Uropathogens *Proteus* spp. In recent years, show a growing resistance to antibiotics, which causes changes in the previously used treatment. Increased antibiotic-resistance complicates the treatment and increases the death rate among geriatric patients. This was noticed among many groups of antibiotics, including β -lactams, or tetracyclines or sulfonamides.

High risk groups of urinary tract infection are: the elderly, patients with anatomical or physiological urinary tract abnormalities, hospitalized patients, patients with long-term catheters, immunodeficient patients or patients with diabetes and pregnant women. It is possible to prevent UTI by observing aseptic technique when inserting a catheter or frequent replacement of catheters. The use of covering the interior of catheters with active pharmaceutical substances significantly reduces the adhesion of bacteria. In addition, it is recommended to use catheters covered with heparin or nitrofurazone and silver oxide, because it causes a significant decrease in the number of urinary tract infections.

Discussion

A review publication written in 2014 at the University of Barcelona, indicating the importance of biofilms in the clinical treatment of urinary tract infections, confirms the exceptional difficulties in treating these infections, due to favorable microbial life conditions in the urinary tract and the tendency for the biofilm to accumulate. The fact of high microbiological resistance at UTI indicates a high degree of difficulty in the therapy of people with this disease entity, which forces to find more and more effective methods of treatment, as well as conducting intensive scientific activity aimed at informing and encouraging representatives of the world of science to operate in this field [38]. Particular attention should be paid to research on urinary tract infection in older people, in which the course of discussed complaints is often uncharacteristic, which significantly hinders correct diagnosis and implementation of therapy. The activities currently undertaken, consisting in the systematic publication of new guidelines and rules of conduct, have a positive effect on the treatment of urinary tract infections of the elderly, but often prove insufficient in dealing with a single patient. The only solution seems to be conducting large clinical trials on the elderly, in the area with many scientific centers [39].

In clinical practice, special attention should be paid to patients after the catheterisation, due to the large role of *Proteus* in UTI after the catheter placement procedure. This significance is special because of the tendency to deposit of kidney stones in the course of UTI due to *Proteus* spp., which is a complication extremely dangerous to health and life. Hopes for the treatment of infections caused by the pathogen discussed above arouse the elements of their functioning, which are still not fully understood, such as the mechanisms of movement [40]. Scientific development raises hopes for increased efficacy in the treatment of infections with the etiology of *Proteus* spp.

In the situation of numerous problems related to the treatment of urinary tract infections caused by *Proteus* spp., the best solution seems to be prevention, boiling down to avoiding infection. In clinical practice, the prevention of UTI during catheterization is of particular importance, due to the relatively high rate of urinary tract infections in catheter patients as well as due to the possibility of serious complications due to infection [41]. Hopes

should also be associated with physiotherapeutic procedures, the effectiveness of which has been confirmed in scientific publications, but the amount of research on the significance of the discussed activities is still too low to become a standard in clinical practice. Reports such as those made by Souza et al., where clinical cases of twelve women with urinary tract infection were described, which were then subjected to pelvic wall physiotherapy to see an improvement in pelvic organs functionalization and the associated greater resistance to urinary tract infections [31], should be present much more often. This would lead to the widespread use of many methods that are currently not appreciated, despite evidence of their effectiveness.

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