Some Biological Properties of Morganella and Providence Strains

M. V. Zarochentsev[1], *L. G.* Molochaeva[2,*], and *R. Kh.* Gayrabekova[1]

[1]Kabardino-Balkarian State University named after Kh.M. Berbekov, Chernyshevsky str., 173, 360004, Nalchik, Russia
[2]Kadyrov Chechen State University, Sheripova Street, 32, 364024, Grozny, Russia

Abstract. Hospital infections are extremely dangerous for the health of the patient, and also pose a danger to others, as they have the ability to spread epidemically. The significance of hospital infections also lies in the fact that they cause a longer stay of patients in the hospital, increase labor losses and lead to increased costs of patient care. Based on this, an attempt was made to identify the presence of pathogenicity factors in clinical strains of Providence and Morganella.

1 Introduction

One of the primary problems of modern medicine and health care has become the problem of nosocomial infections. In the book “Nosocomial Infections” D. Losonzi writes “... there is no nosocomial infection only in those departments where they do not want to take it into account” [23]. The problem of nosocomial infections is classified by WHO as one of the most urgent and finds significant coverage both in domestic literature and abroad [7, 8, 21, 22, 23].

The causative agents of purulent-inflammatory diseases are primarily opportunistic microorganisms. Bacteria of the Morganellaceae family, along with other microorganisms, are also involved in the acute problem of nosocomial infections. The proportion of individual pathogens of different species of this family varies depending on the nature of the disease. Most often, microorganisms of this group are isolated from urinary tract infections, wound suppuration processes, and gynecological inflammatory diseases [22]. representatives of the genera Morganella and Providencia, while there is an increase in the number of cases of nosocomial infections caused by these bacteria [8]. However, insufficient knowledge of these microorganisms, difficulties in their identification and differentiation from other genera, as well as within genera and within species, create serious problems. In this regard, we set the task to study the main biological properties of Morganella and Providence strains.

2 Research Methodology

*Corresponding author: l_molochaeva@mail.ru

We used 39 strains identified as Morganella morganii and 34 strains assigned to the genus Providencia, including 25 strains of Providencia rettgeri, 5 strains of Providencia alcalifaciens, and 4 strains of Providencia stuartii.

Most of the strains were isolated from clinical material, strains of Morganella and Providencia were most often found in urine and in wound discharge, including in acute processes, in 13.2%, in chronic ones, in 86.8%. Only one strain was isolated from non-clinical material - a food product.

The sensitivity of Morganella and Providencia to antibiotics was determined by diffusion into agar using a set of standard disks [13, 22, 23]. The sensitivity of Morganella and Providencia to antibiotics was determined in relation to 14 drugs: gentamicin, methicillin, carbenicillin, streptomycin, ampicillin, monomycin, neomycin, kanamycin, tetracycline, benzylpenicillin, erythromycin, rifampicin, ristamycin, levomycetin.

Lysozyme activity was determined by the method of "delayed antagonism" [1, 3-5, 9, 11, 12, 14, 19, 21-23].

The antilysozyme activity of morganella and providence was determined according to the method of Bukharin O.V. and co-authors [1, 3, 4, 6, 9, 11, 12, 14–16, 19, 21–23].

The ability of the studied cultures to hemagglutinate sheep erythrocytes was studied in the reaction with a 3% suspension of fresh sheep erythrocytes. D-mannose-resistant activity was determined after the addition of 1.5% mannose [1-4, 11, 12, 14, 18, 19, 21-23].

The presence of hemolysins was determined on 1.5% nutrient agar containing 3–5% rabbit erythrocytes. To determine thiol-dependent hemolysins, 0.002% L-cysteine was added to agar [1, 3, 4, 10-14, 17, 19-23].

3 Results and Discussions

A sensitivity test to antibacterial drugs showed that none of the tested strains of morganella and providenium was sensitive to methicillin, streptomycin, ampicillin, benzylpenicillin, rifampicin, ristomycin, neomycin, erythromycin. The drugs of choice for morganella can be gentamicin, kanamycin and levomycetin, which are detrimental to the tested strains of morganella in 39.5%, 28.2% and 20.5% of cases, respectively. The percentage of strains resistant to all tested antibiotics among Providences (88.2%) is significantly higher ($p<0.05$) than among Morganellas (48.7%). 69.2% of Morganella strains and all Providence strains have multiple antibiotic resistance. Strains that are resistant to at least 12 out of 14 tested antibiotics are conditionally classified as multiresistant.

Adhesive properties are an important characteristic of the pathogenic properties of bacteria. Determination of adhesive properties was carried out by the ability of bacteria to agglutinate sheep erythrocytes in the presence of D-mannose and without it.

The test results indicate a more frequent distribution of strains with hemagglutinating ability among Providences (79.4% of cases) than among Morganellas (58.9% of cases). However, Morganella strains more often produce mannose-resistant hemagglutinins than mannose-sensitive ones (in 65.2% and 34.8%, respectively), while in Providence, the frequency of detection of mannose-resistant and mannose-sensitive hemagglutinins is approximately the same. Mannose-sensitive hemagglutinins were found in 55.6% of hemagglutinin-producing Providence strains, and mannose-resistant hemagglutinins were found in 44.4% of strains.

Anti-lysozyme activity, which contributes to the resistance of bacteria to serum lysozyme, is inherent in some strains of both Morganella and Providence.

This pathogenicity factor was found in 61.5% of Morganella strains and in 50.0% of Providence strains.

A quantitative study of anti-lysozyme activity showed that, in general, Morganella and Providencia strains are characterized by anti-lysozyme activity in the range from 1 to 4 μg/ml, and Morganella strains, as a rule, have a higher anti-lysozyme activity.

All cultures were tested for lysozyme activity. However, only one morganella strain was able to produce lysozyme. Other strains of Morganella and all strains of Providence did not have this ability.

Determination of hemolytic activity of cultures was carried out using rabbit erythrocytes. As a result of the study, it was found that most morganella strains (53.8%) have the ability to produce hemolysins. Moreover, α-hemolysins are found in all strains of morganella with hemolytic activity. Providence cultures do not possess hemolytic activity. Differences in the hemolytic activity of Morganella and Providence strains are statistically significant ($p<0.05$).

As a result of the research, significant differences were established between the strains of morganella and providence.

Most of the strains of Morganella and Providence tested have several pathogenicity and virulence factors.

Both Morganella and Providencia are characterized by significant multidrug resistance to antibiotics. Adhesive properties are more pronounced in providences. However, Morganella strains more often produce mannose-resistant hemagglutinins than mannose-sensitive ones (in 65.2% and 34.8%, respectively), while in Providence, the frequency of detection of mannose-resistant and mannose-sensitive hemagglutinins is approximately the same.

As a result of the study, it was found that most morganella strains (53.8%) have the ability to produce hemolysins. Moreover, α-hemolysins are found in all strains of morganella with hemolytic activity. Providence cultures do not possess hemolytic activity.

Antilysozyme activity, which contributes to the resistance of bacteria to serum lysozyme, is inherent in 61.5% of Morganella strains and 50.0% of Providence strains.

Only one strain of morganella was able to produce lysozyme, all other cultures of morganella, as well as all strains of providence, did not have such an ability.

4 Conclusions

1. The study showed that antibiotic resistance is widespread among the strains of Providence and Morganella tested. The percentage of strains resistant to all tested antibiotics among Providences is significantly higher ($p<0.05$) and amounts to 88.2% than among Morganellas - 48.7%. 69.2% of Morganella strains and all Providence strains have multiple antibiotic resistance.

2. The test results indicate a more frequent distribution of strains with hemagglutinating ability among Providences (79.4% of cases) than among Morganellas (58.9% of cases). However, Morganella strains more often produce mannose-resistant hemagglutinins than mannose-sensitive ones (in 65.2% and 34.8%, respectively), while in Providence, the frequency of detection of mannose-resistant and mannose-sensitive hemagglutinins is approximately the same.

3. Anti-lysozyme activity was detected in 61.5% of Morganella strains and in 50.0% of Providence strains. A quantitative study of anti-lysozyme activity showed that it ranges from 1 to 4 μg / ml, and Morganella strains, as a rule, have a higher indicator of anti-lysozyme activity. Lysozyme activity from all cultures of providence and morganella was detected only in one strain of morganella.

4. Most of the studied morganella strains (53.8%) have the ability to produce hemolysins. Moreover, in all these strains, α-hemolysins are found. Providence cultures do not possess hemolytic activity.

References

1. S. K. Aishanov, Some features of opportunistic pathogens, 260-262 (2011).

2. R. A. Achaev, Adhesive ability of some opportunistic enterobacteria isolated from sheep with associative helminthic-bacterial diseases, **2(35)**, 113-118 (2011).
3. L. Z. Blieva, R. Kh. Gairabekov, Comparative study of bacteria of the genus Serratia, **1**, 46 (1996).
4. V. B. Boziev, Correlation between antilysozyme activity and other factors of enterobacteria pathogenicity, **1**, 27-28 (1994).
5. O. V. Bukharin, Lysozyme microorganisms, 211 (1985).
6. O. V. Bukharin, Method for determining the antilysozyme activity of microorganisms, **2**, 27-29 (1984).
7. V. V. Vlodavets, Reducing the number of nosocomial infections is an urgent task of modern medicine, **1**, 143-145 (1989).
8. V. V. Vlodavets, Microbiological aspects of nosocomial infection, 287-289 (1974).
9. I. M. Gabrilovich, Factors of pathogenicity of enterobacteria and their detection, 32 (1993).
10. I. M. Gabrilovich, Experimental study of toxicoseptic syndrome caused by opportunistic enterobacteria, 63-64 (1997).
11. R. Kh. Gairabekov, Hemolytic activity and sensitivity to antibiotics of some, 7-50 (2019).
12. L. G. Molochaeva, Some features of the epizootic process in enterobacteriosis of small cattle on the territory of the Chechen Republic, **4**, 6-12 (2019).
13. R. Kh. Gairabekov, Antilysozyme, antiinterferon and anticomplementary activity of some bacteria of the enterobacteriaceae family, **5**, 329 (2016).
14. R. Kh. Gairabekov, Antilysozyme activity of some enterobacteria, 63-64 (2016).
15. D. Losonzi, Nosocomial infections, 453 (1978).
16. N. A. Semina, Theory and practice of combating nosocomial infections, **2**, 168-170 (1989).
17. F. S. Turlova, Production of hemolysins by bacteria of the genus Serratia, **1(17)**, 126-128 (2015).
18. O. S. Yakushenko, Pathogenicity factors of some opportunistic enterobacteria, 55-59 (1991).
19. I. Albesa, L. I. Barberis, M. K. Pajaro, M. K. Faraochi, A. J. Fraso, A thiol activated-hemolysin in gram-negative bacteria, **31**, 297-300 (1985).
20. I. M. Gabrilovich, V. B. Boziev, R. Kh. Gayrabekov, K. Ju. Lotiev, Epidemiological markers of opportunistik enterobacteria, 268 (1990).
21. L. Molochaeva, Some features of the bacteria of the family enterobacteriaceae allocated from small cattle at different pathological processes, **14(4)**, 7322-7327 (2020).
22. V. Q. Hemming, J. C. Okerall, M. R. Britt, Nosocomial infections in a newborn intensive care unit: results of forty-one months of surveillance, **294**, 1310-1316 (1976).
23. J. R. Perfect, M. E. Klotman, Hospital-acquired infections, 392-399 (1985).