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BRONCHPNEUMONIA AS A HEALTH PROBLEM ON PIG FARMS (RESEARCH REVIEW)

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Summary

Bronchopneumonia is one of the most important respiratory diseases in pigs in intensive breeding. Bronchopneumonia rarely occurs and passes as a monoinfection, and therefore mixed infections are the most common finding. Isolated microorganisms include, for example, Porcine reproductive and respiratory syndrome virus (PRRSV), Porcine circovirus type 2 (PCV-2), *Mycoplasma hyopneumoniae*, Influenza virus, *Actinobacillus pleuropneumoniae, Pasteurella multocida*, *Bordetella bronchiseptica*. Of particular importance in the development of bronchopneumonia in pigs are non-specific factors, such as transport, low temperature, inadequate nutrition, environmental conditions in the boxes, overcrowding and other stressors. Pulmonary pasteurellosis is the result of a lung infection with the bacterium *Pasteurella multocida*. It most often occurs as the last stage of enzootic pneumonia or a complex of respiratory diseases in pigs. The complex of respiratory diseases is one of the most common and economically most expensive diseases of pigs, especially if the pigs come from commercial farms. Pulmonary pasteurellosis is present in different housing conditions of pigs. *P. multocida* as a frequent resident of the nasal flora of pigs is difficult to eradicate since it can interact with many other pathogens. The aim of our study was to examine the antimicrobial susceptibility of bacterial isolates originating from pigs in intensive production.
Keywords: antimicrobial susceptibility, bronchopneumonia, pigs.

Bronchopneumonia or exudative pneumonia is the most common form of pneumonia in pigs and is usually accompanied by cranioventral lung consolidation. Bronchopneumonia can be caused by bacteria, mycoplasmas or food aspiration. Due to the filling of the lungs with exudate, the lungs become hard. According to the quality of exudates, bronchopneumonia can be divided into purulent and fibrinous, although in some cases it is impossible to draw the line between these two types, given that they can be found simultaneously in the lungs or that one form of inflammation can spread to another (18, 19). Purulent bronchopneumonia is characterized by the accumulation of purulent or mucopurulent exudates in the airways and has a lobular distribution. The inflammatory process in purulent bronchopneumonia is limited to certain lobules of the lungs, which is especially pronounced in pigs. As a result of this distribution of lesions, the lungs affected by purulent bronchopneumonia resemble a chessboard, as a result of mixing color and appearance of unchanged and consolidated lobules. In some cases, abscesses form in the lungs, so this form of purulent bronchopneumonia is referred to as apostematous bronchopneumonia (6, 9). In pathomorphological diagnostics, the appearance of the lungs varies depending on the age of the process. For the first 12 hours, the lungs are swollen and red due to active hyperemia and edema, which are present in the early phase of inflammation. By 48 hours, the lung parenchyma consolidates due to the exudation of neutrophilic granulocytes into the alveoli, bronchioles, and bronchi. The lungs are gray-pink in color and have a harder consistency, and in three to five days they become pale gray, similar to the color of fish meat. Pathohistological diagnosis reveals many neutrophilic granulocytes, macrophages, and desquamated cells in the alveoli, which in extreme cases of purulent bronchopneumonia completely obliterate the lumen of the bronchus, bronchioles, and alveoli (9). *Streptococcus* spp. and numerous species of mycoplasmas, of which *Mycoplasma hyopneumoniae* is the most important for pigs (2, 3, 18).

According to the morphological division, fibrinous pneumonia is exudative pneumonia which is characterized by accumulation of fibrin in the bronchoalveolar spaces. In fibrinous bronchopneumonia, unlike purulent, whole lobes are affected by the changes, which is why fibrinous pneumonia is also called lobar, unlike purulent lobular bronchopneumonia. Fibrinous bronchopneumonia is always preceded by intense damage to blood vessels with appropriate noxa, and this type of bronchopneumonia proceeds through four stages: splenization stage, red hepatization stage, gray hepatization stage, resolution stage (9). In case of unfavorable outcome, there may be a process of organization, which often ends with the growth of parenchyma connective tissue, so the process of fibrinous pleuropneumonia develops in the direction of pulmonary fibrosis, and sometimes fibrous adhesive pleurisy, when adhesions can affect the pericardium (9). One of the complications of fibrinous bronchopneumonia can be necrosis of altered areas of the lung parenchyma, when due to thrombosis of lymphatic and blood vessels, tissue nutrition is prevented and focal foci of coagulation necrosis in the lungs occur, which may be due not only to ischemia but also to pathogenic bacterial toxins (8). The most common causes of fibrinous bronchopneumonia are *Actynobacillus pleuropneumoniae, Pasteurella multocida* and *Mycoplasma hyopneumoniae* (12, 18). Interstitial pneumonia is characterized by an inflammatory process in the interstitium of the lungs. The final diagnosis is made based on pathohistological findings (9). Unlike bronchopneumonia, interstitial pneumonia affects all lung lobes, although in some cases the dorsocaudal distribution of lesions is present. The lungs have a light gray color, mainly due to obliteration of the pulmonary capillaries, and the fleshy or rubbery consistency, without exudates on the cross-section in uncomplicated cases, originates from cellular infiltration of the pulmonary interstitium. The lungs affected by interstitial pneumonia are rubbery, so they do not collapse after opening the chest cavity, and they have the texture of raw meat on the cross-sectional surface (9). Interstitial pneumonia most often occurs because of aerogenic damage to the alveolar epithelium (toxic gases, free radicals, pneumotropic viruses), but also hematogenous damage to pulmonary capillaries (septicemia, disseminated intravascular coagulopathy, endotheliotropic viruses) or due to local release in the lungs. Based on morphological characteristics, the findings in the acute and chronic course of interstitial pneumonia differ significantly (14, 18). Often, interstitial pneumonia occurs without clear clinical symptoms. As pigs are most often mixed infections (polyinfections), both forms of pneumonia, bronchopneumonia, and interstitial pneumonia, can develop in parallel or can arise from each other. It should be emphasized that interstitial pneumonia is always a precursor to bronchopneumonia. The lungs can respond differently to many agents, and of very different intensity. Morphologically similar changes can be caused by different causes, i.e., the etiologically unique process can go through different stages of morphological changes (9). In all pneumonias, the clinical picture is almost the same. On the other hand, pathomorphological changes may differ in the degree of development of the process and the substrate, which is a consequence of the biological characteristics of the causative agent, virulence and associated action (1, 18).

The aim of our study was to examine the antimicrobial susceptibility of isolates from lung lesions of pigs in intensive production.

Materials and methods

The lung lesions samples were taken under sterile conditions, plated on blood agar plates (blood agar with 5% ram blood) and incubated aerobically at 37°C for 18–24 h. Bacterial isolates were identified using standard methods for phenotypic characterization as previously described (16).

Results and discussions

Many etiological factors participate in the development of respiratory diseases in pigs, with live agents playing the primary role (Table 1, Fig.1). Diseases are rarely caused by a single agent, but they are most often mixed infections (3, 4, 5). The classical division of pathogens into primary (those that are capable of causing the disease themselves) and secondary (those that cause the disease in cooperation with other predisposing factors or pathogens) is becoming less and less acceptable (14). This is due to the fact that a large number of secondary pathogens can cause significant diseases on their own, and on the other hand, a number of isolates or strains of primary pathogens cause very mild or no clinical symptoms of respiratory disorders (6, 18, 19).

The primary causes of respiratory diseases in pigs are PRRSV, swine influenza virus (Swine Influenza Virus - SIV), swine circovirus type 2 (Porcine Circovirus type 2 - PCV-2, eng), *Mycoplasma hyopneumoniae, Actynobacillus pleuropneumoniae, Bordatella bronchoseptica* in some cases, the virus that causes Aujeszky's disease (Pseudorabies Virus - PRV, eng) and respiratory coronavirus (Porcine Respiratory Coronavirus - PRCV, eng). Among the secondary causative agents, the most important *are Pasteurella multocida, Haemophilus parasuis, Streptococcus suis, Actinobacillus suis, Arcanobacterium pyogenes and Salmonella choleraesuis* (13).

Table 1

Antimicrobial susceptibility of isolated bacteria from pig lungs (%)

	Penicillin	**Ampicillin**	**Amoxicillin**	**Amoxicillin-Clavulanic acid**	**Tetracycline**	**Cephalexin**	**Gentamicin**	**Neomycin**	**Streptomycin**	**Sulfa Prep.**	**Enrofloxacin**	**Florfenicol**
Mannheimia	100	100	100	100	100	100	100	100	0	0	100	100
Pasteurella	11	11	11	11	11	22	78	56	0	56	3	89
Streptococcus	100	100	100	100	75	100	0	0	0	75	100	100
Pseudomonas	0	0	0	0	0	0	0	50	0	0	0	100
Haemophilus	100	100	100	100	100	100	100	100	0	100	100	100
E. coli	0	0	0	0	0	100	50	50	0	100	100	100

With the introduction of new diagnostic methods, there is a change in the list of pathogenicity of the causes of respiratory infections. Thus, it has recently been stated that of the infectious agents, a significant role in the etiopathogenesis of respiratory infections belongs to the swine reproductive and respiratory syndrome virus and *M. hyopneumoniae* (12, 18). The special significance of these pathogens is evidenced by the results of conducted research in pig farms in Serbia (20, 21, 22). Characteristically, many of the respiratory pathogens can appear as independent causes, or as often as possible, mutually united in synergistic action. Their prevalence and frequency of occurrence varies, both from west to west, and within the west itself, depending on the technological-production group (17).

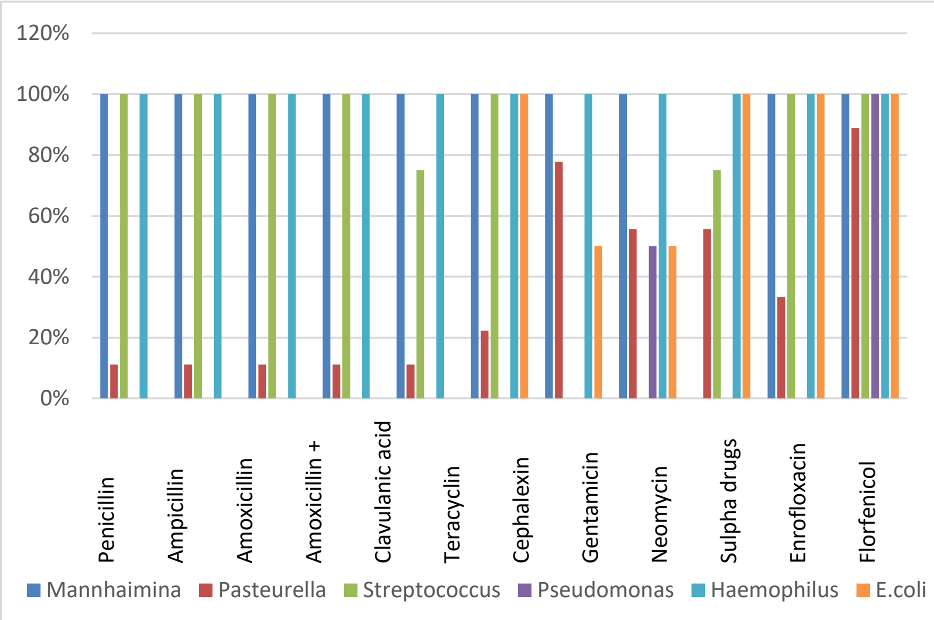

Fig. 1. Antimicrobial susceptibility of isolates

Many of these pathogens can be found simultaneously or sequentially in the same pig farms. In addition to the above, this is the reason that their classical division into primary and secondary respiratory pathogens is not always completely acceptable (7). Some pathogens, previously designated as secondary pathogens, such as *Pasteurella multocida*, can cause the disease on their own and are then considered the primary pathogen (18). It is important to note for diagnostic purposes that the interaction of pathogens is very complex and that each of them independently, in synergism or competition causes a certain manifestation of the disease from the respiratory complex (12). In addition to living agents, special importance is given to non-infectious, i.e., predisposing factors, such as transport, low temperature, bad microclimate, deficient nutrition, overcrowding in box, frequent effects of stress factors. A characteristic of the modern method of production is the formation of agglomerations with a concentration of a large number of individuals in a small space. The consequence is the daily production of large amounts of gases, water vapor, heat and bioaerosol particles, which directly affect the change in physical and chemical composition of the air inside the building, and thus the animal organism (17). In particular, such conditions affect respiratory pathogens and their continuous maintenance of a high degree of virulence in vivo (12). Harmful gases such as ammonia, methyl amine and hydrogen sulfide, which have toxic effects in high concentrations, also have a noticeable but limited role. It was found that ammonia in experimental conditions, at a concentration of 50 ppm and in production conditions at a concentration of 20 ppm, impairs the function of cilia and thus significantly impairs the defense ability of the mucosal epithelium. Dust, which is usually present in large quantities in pig facilities, has a detrimental effect on the nasopharyngeal and bronchial ciliated epithelium mechanically and chemically. Due to the increased action of predisposing factors, the epithelium of the mucous membrane of the respiratory system is damaged, its activity is reduced, and thus the possibility of continuous elimination of accumulated exudate and inhabited microorganisms (17).

It is inevitable to mention a number of predisposing factors that participate in the occurrence and development of respiratory infections. These are usually significant changes in environmental conditions such as cooling, sudden changes in temperature, increased humidity, overcrowding, poor hygiene, parasitic infections, all of which contribute to the development of the disease. The result is a more frequent occurrence of respiratory infections which are difficult to control, and which are significantly affected by the conditions of keeping in large agglomerations. Technological systems that do not include the "all-in / all-out" procedure, and contain pigs from various localities, introduce gilts into breeding without prior health control and thus form groups of different immune status, thus enabling throat infection in the west by numerous pathogens (15). Changes in environmental conditions lead to stress, which, like various infectious agents, can significantly suppress the respiratory defense mechanisms in pigs. To this should be added the fact that our farms rarely carry out the procedure "rest facility", which would allow minimal exposure to endemic pathogens and thus lead to the development and equalization of the immune status of all individuals in the group (12).

Non-infectious factors can promote the action of mycoplasmas or viruses, which cause primary damage, which is a suitable basis for the settlement and reproduction of other living agents. In this way, a synergistic effect of specific and non-specific factors is achieved, which indicates all the complexity of the etiopathogenesis of diseases of the respiratory system of pigs. At the same time, a very important factor in the pathogenesis of the disease is the susceptibility of the blood vessels of the lungs to the action of numerous immune processes. As a result, damage to the walls of blood vessels occurs, their permeability increases, and consequently edema is created, which is a suitable basis for further pathogenic action of many agents (18).

The harmful effects of etiological factors, as well as their mutual relationship, are constantly being studied. The action of living agents or their toxic products disrupts the defense activity in the lungs, which makes circulation especially difficult, especially in the parenchyma around the edges of the lung lobes. Non-specific factors, such as microclimate and low temperature, are especially important. It has been proven that peripheral cooling can cause disturbance of blood flow through the lungs, with consequent changes in ciliary activity, mucus production, reduction of local cellular and immune defense activity (18). The pathomorphological changes that occur in respiratory infections are characteristic and depend on the type of infectious noxa, as well as on the ways in which they reach the lungs. The most common route of infection is aerogenic, so that the pathogens reach the lungs through the bronchial tree, where they first spread endobronchially, and then secondarily through the lymphatic pathways to the peribronchial spaces. The pathogens can reach the lung tissue and be hematogenous, especially after septicemic conditions. They first settled in the interalveolar or peribronchial space (11).

There are different views regarding the spread of the causative agent and the occurrence of aerogenic infection. It is believed that nasal secretions, as infectious material, can reach the oral cavity and thus enable the causative agents to first settle in the tonsils and pharyngeal mucosa, and from there reach the respiratory tract (12, 18).

Therapy with antimicrobial drugs is expensive, difficult, and often unsuccessful, the prevention of pneumonia deserves and received more attention. Prevention is usually reduced to changes and improvements in critical breeding points. Techniques in management have been processed by a large number of authors, so attention must be paid to the implementation of their recommendations, because they are recommended on the basis of epidemiological studies, and not from experimental research. They were also done to prevent the occurrence of respiratory diseases and not to differentiate between agents of different etiology. Changes in management can be modification of facilities and reduction of the possibility of spreading microorganisms. Changes in the environment such as increased ventilation, reduced ammonia concentrations, reduced building temperature fluctuations, and reduced dust are some of the most common recommendations. Some of these recommendations cannot be combined, such as increasing the air exchange in winter, resulting in a decrease in the temperature in the building and an increase in humidity, as well as an increase in the amount of dust (10).

Conclusions

Bronchopneumonias of various etiologies cause great damage and problems in pig breeding, and they must be fought against on higher fronts, such as the introduction of new and proven pig breeding technologies, where animals receive complete health care. Prophylaxis should be given as much attention as possible, because only in that way can losses be reduced to a minimum.

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