

SELECTED BACTERIAL ZOONOSES IN MEDICAL PRACTICE

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ABSTRACT

Introduction. Zoonoses present a serious problem for medical pathology. According to epidemiologists, the occurrence of these diseases is significantly differentiated worldwide, because of dissimilar biotope structures found in particular latitudes and climatic zones.

Aim. The main aim of this work was to present the most important data concerning bacterial zoonoses occurring in Poland. Their etiology and epidemiology, including the methods applied to break the epidemiological chain, are discussed.

Materials and methods. The material used in this work consisted of available subject literature.

Discussion. Bacterial zoonoses are caused by microorganisms, which have adapted to human beings and specific animal species during phylogenesis. Sources of infection include sick or cured animals. Infections may be transmitted via animal products, slaughter products, as well as various elements of that environment contaminated by excrement from sick animals.

This work emphasizes the more frequent prevalence of such diseases found in rural environments as well as among representatives of specific professions. Medical procedures in the event of recognizing such a disease are presented, including the official rules of veterinary actions against these diseases occurring in animals.

Conclusions. 1. Prophylaxis is critical for controlling bacterial zoonoses. 2. Close cooperation of epidemiologists and specialists in epizootology is the key issue regarding efficient prophylaxis (EU directive concerning zoonoses reports from EU members). 3. Societal education with respect to zoonoses will definitely contribute to their less frequent occurrence.

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INTRODUCTION

Zoonoses present a serious problem for medical pathology. They occur in specific socio-economic conditions which prove favorable for infections, especially in a rural environment. They pose a serious threat to children whose immune systems are not yet fully developed. Thus, all types of infections caused by animal pathogens occur more easily and quicker in children than in adults, and the disease course is more severe. Zoonoses are defined either as diseases or infections which are transmitted naturally from animals to humans; whereas a zoonotic agent is understood to be bacteria, virus, fungi, or parasite which causes zoonoses [8].

The World Health Organization (WHO) experts committee has established a list of 134 zoonoses, but at present there are more than 200 such diseases as their numbers increase each year [16]. This results from the closer contact of man with his environment which serves as a reservoir for zoonoses, as well as containing their agents and vectors. Because of their etiology, zoonoses are divided into infectious and parasitic diseases. Infectious zoonoses are caused by pathogenic factors which have adapted to human beings and specific animal species during phylogenesis. Their etiologic factors may include some bacteria and viruses, and recently, even modified prions. Sources of infection include sick or cured animals. Infections may be transmitted via animal products, slaughter products, as well as various elements of that environment contaminated by excrement from sick animals.

AIM

The main aim of this work is to present the most important data concerning bacterial zoonoses occurring in Poland. Their etiology and epidemiology, including the methods applied to break the epidemiological chain, are discussed. The role of zoonoses in public health, an area recognized worldwide as very important, has been emphasized.

MATERIALS AND METHODS

This work is based on available literature concerning this subject.

DISCUSSION

The more important zoonoses occurring in Europe include: anthrax, tuberculosis, brucellosis, salmonellosis, leptospirosis, botulism, and borreliosis [2].

Anthrax is an infectious, septic disease caused by the bacterium *Bacillus anthracis* which, in unfavorable conditions (in the air), produces spores extremely resistant to the outside environment. This disease primarily affects herbivores; humans are

susceptible to a lesser degree. One of the most serious epidemics of anthrax occurred in San Domingo in the 18th century. It involved cattle, horses, mules, goats, cows, cats and chickens, and killed nearly 1500 people [11]. In Europe, anthrax is found sporadically. The last time it was reported was in the year 2000 in the Danube delta in Romania. At present, it is found in some regions of Asia, South America, and Africa [16]. The disease sources include: soil, animal excrement, skin, fur fleece, infected animals and their meat.

In humans (including children) a cutaneous form most frequently occurs, manifested by painless blisters on hands or head, turning into black crusts (carbuncles). Untreated infections may occasionally lead to septicemia. Inhalation anthrax is initially manifested by fever, then the disease progresses to pneumonia and a state of shock. Intestinal anthrax is accompanied with high temperature and severe bloody diarrhea.

Mortality in humans suffering from untreated pulmonary anthrax reaches 100%, from intestinal anthrax about 50%, and in the case of cutaneous anthrax it does not exceed 20%. Anthrax is treated with antibiotics and symptomatic treatment [18].

The bacteria *B. anthracis* have a relatively low level of resistance with respect to external agents. Disinfectants kill them quickly. In gastric juice *B. anthracis* die after 15–20 minutes, at temperatures of 55–58°C within 10–15 minutes, and in a buried corpse after approximately 4 days. At a temperature of –15°C the bacteria are destroyed after about 2 weeks, whereas corning takes as long as 1.5 months to kill them. Anthrax spores are much more resistant. In dry animal material they may survive for years, just as in water, and especially in burial soil (at a depth of 1.5 m) where they were found even after 24 years had elapsed. Neither meat corning nor gastric juice affect spores, whereas at temperatures of 120–140°C (dry air) they die after 3 minutes, in steam (100°C) within 5 minutes. Spores are destroyed by formaldehyde, 5% potassium permanganate, 5% phenol, and 5% fresh calcium chloride [13].

Due to a significant pathogenicity and resilience of anthrax spores, they are classified as biological weapons posing a serious terrorist threat. The last noted usage of anthrax as a terrorist weapon, known from media, occurred in the USA in 2001, when 22 people were infected via the mail, and 5 of them died [16].

Anthrax in animals is controlled ex officio, and carcasses of infected animals are considered unfit for consumption [13].

Tuberculosis, according to WHO, at the beginning of the 21st century still remains a health problem of a global nature.

Approximately 30% of the world's population (about 2 billion people) is infected with tuberculosis; 7–8 million people develop this disease, and about 2–3 million die annually from it. Poland is one of those countries with a high incidence of tuberculosis, with its incidence level being twice higher than that of the Czech Republic, and 5-times higher than that of Norway and Sweden [14]. It has been shown that rural

area residents suffer from tuberculosis more frequently than urban area residents, and men twice more frequently than women. The incidence of tuberculosis in children accounted for about 1% of all registered cases in 2003. It should be added that due to diagnostic difficulties in children, they should be diagnosed by medical teams in well-equipped centers. A special board established at the Tuberculosis and Lung Diseases Institute in Warsaw has questioned the correctness of diagnoses in 30.0% of cases. Tuberculosis-related deaths account for 0.2% of all deaths and 37.4% of infectious diseases-related deaths [14].

Tuberculosis is also found in animals. They serve as reservoirs and sources of infection for humans. It can be also transmitted from humans to animals. It is caused by *Mycobacterium tuberculosis* represented by 3 pathogenic species of the genus *Mycobacterium*: *tuberculosis*, *bovis* and *avium*. *M. tuberculosis* causes tuberculosis mainly in people, rarely in animals. *M. bovis* is the main cause of tuberculosis in cattle, but may also affect people and other animal species. *M. avium* affects mainly birds, whereas humans are relatively resistant to it.

M. tuberculosis is very resistant to external agents. It has been discovered to have survived in the lungs of buried, deceased people after 167 days, and in the intestinal content after 178 days. It survives in the organs following 1.5-months of corning, and in cold cooked meat after a 15-minute scalding at a temperature of 85°C. *M. tuberculosis* is killed by boiling or pasteurizing milk whereas it survives up to 15 days in sour milk, in cream butter up to 4 weeks, and in salted butter (4–6%) up to 5–10 days. Effective disinfectants include: 2% phenyl solution, 1% cresol and 3% formalin, which destroy mycobacterium within 4 hours, whereas in 80% ethyl alcohol destruction occurs after 10 minutes [13].

In natural conditions, infection with *M. bovis* in cattle occurs via direct or indirect contact with contaminated objects. In 95% of cases, infections occur via the respiratory tract, in 4% via the alimentary tract and, in about 1% of cases, via the skin or mucous membrane [19]. In cattle, pathological changes generally involve lungs and bronchial and mediastinal lymph nodes, rarely other organs; whereas in pigs, changes are located mainly in the alimentary tract.

In humans, the main etiological factor is *M. tuberculosis* transmitted by infected people; less frequently it is *M. bovis* transmitted by milk or contact with an infected animal. It should be emphasized that no infections of humans caused by dogs and cats which can be infected by *M. tuberculosis* and *M. bovis* have been noted [19]. Human-to-human infections with *M. bovis* are very rare, and clinical symptoms of infected people may be the same as in *M. tuberculosis* infection [4]. Recently in Europe, due to long-term efforts to control tuberculosis in cattle, there has occurred a shift in the sources of infection due to fowl, with *M. avium* being the infectious agent. This may contribute to an increase in the incidence of infections and the development of avian tuberculosis by humans. Fish tuberculosis, especially that involving aquarium fish, cannot be overlooked. The etiological factors for these infections

include: *M. piscium*, *M. asinum* and *M. fortuitum* characterized by foodborne transmission, and in viviparous fish by transovarian transmission. The sources of infections include: contaminated water, sand, plants, and aquarium fish. Mycobacterium hosted by fish may cause cutaneous forms of tuberculosis in humans [16].

Tuberculosis is treated with complex anti-mycobacterial chemotherapy which usually leads to a complete cure.

Prophylaxis involves: vaccinations, isolating sputum-positive patients, improving the living conditions of the population, examining people who have come into contact with sources of infections, performing tuberculin skin tests, and chemoprophylaxis.

Tuberculosis is a disease controlled ex officio, and in people tuberculosis treatment is compulsory. Cattle infected with tuberculosis are not treated, and animals with positive tuberculin reaction are slaughtered. When tuberculosis is recognized after slaughter occurs, the entire carcass is considered unfit for consumption [13].

Brucellosis is a bacterial disease originally occurring in animals, but transmitted to humans. The etiological factors are bacteria of the genus *Brucella*: *melitensis*, *abortus*, *suis*, and *canis*, very common worldwide. In Central Europe the bacterium *B. abortus* is most common in cows, and in southern Europe, especially in Mediterranean countries, in goats. The main reservoirs for the bacteria include: infected fetus, fetal membranes, and amniotic fluid. Among animals the infection is transmitted after consuming contaminated fodder or water or through damaged udder and extremities skin. In the course of this disease cows excrete the bacteria with milk and excrement. The bacteria survive 8 months in an aborted fetus; up to 3–4 months in feces, urine, and liquid manure; up to 2–3 months in wet soil. At 60°C the bacteria are destroyed after 30 minutes, at 86°C after 5 minutes, and at 100°C immediately. *Brucella* bacterium survives meat pickling even in pH 4.0 environment. In corned and smoked meats it was discovered after 63 days. In frozen meat it survives up to 460 days, whereas in a 25% saline at 0°C up to 21 days [13].

In humans, high risk groups involve: people employed in barns and slaughterhouses, as well as veterinarians (in the 1970s in the Province of Gdańsk, in such a group 18.6% manifested a positive agglutination reaction) [9]. Humans are infected by infected animals, unpasteurized milk of infected animals, and cheese produced from such milk. Once transmitted to a given organism, the bacteria locate themselves in the lymph vessels of the lymph nodes where they multiply, and then penetrate into blood and other organs causing inflammation. In pregnant women, they penetrate to the fetus, leading to abortion. The incubation period lasts 7–8 weeks. Clinical symptoms include: fever, nausea, general weakness, sweating, headaches, arthralgia, and hepatosplenomegaly. After a year, the disease becomes chronic, accompanied with general weakness and arthralgia, and in women it leads to infertility [16]. In Poland, brucellosis is extremely rare, e.g., 63 cases were reported in 1997, 43 cases in 1999, and 29 in 2000 [5], whereas in 2006 no cases were reported [9].

Salmonellosis is an acute infectious disease (food poisoning) caused by *Salmonella* bacteria, occurring mostly in animals, but also in humans. Salmonellosis reservoirs often include: undiagnosed vectors, humans and animals excreting the bacteria into the environment in their feces, as well as animals during abortion, when the bacteria are excreted with the fetus, placenta, and amniotic fluid. *Salmonella* bacteria may survive for months and years in waste, water and soil, where they can multiply. They also congregate in animal-derived food products. The bacteria are very resistant to low temperature, e.g., in raw turkey meat stored in -18°C living bacteria were found after 3 months. *Salmonella* bacteria are sensitive to high temperatures; they die during meat cooking, and at 70°C after 10–15 minutes. They are slightly sensitive to saline, e.g., in a 20% saline at 25°C after 47 days their number is 10-times reduced [13].

Animals, especially young ones, may be infected through consuming fodder and by contact with litter. Following such an infection, bacteria penetrate into the alimentary tract, and then to blood and internal organs, where they multiply until developing clinical symptoms in the infected organism (fever, diarrhea, dehydration). In pregnant animals, they can also penetrate into the placenta and fetus leading to death [18, 19].

Infection in humans is only possible through infected food (meat, milk, eggs) or food infected during its processing. Direct infections may occur when proper hygiene is not observed. Newborns, children, and youth are most susceptible. The incubation period is short, 6–48 hours from becoming infected. Depending on the infectious dose, host sensitivity and bacterial stereotype, this disease may run various courses, from mild diarrhea to severe illness, accompanied with fever, diarrhea and vomiting. Children may manifest febrile convulsions. Frequent defecation quickly leads to dehydration, especially dangerous for children and older people, causing renal function failure. Fever and vomiting usually subside after 1–2 days, whereas diarrhea and stomach ache continue for 5–10 day. During the course of this disease, bacteria are excreted continually, and then over several weeks at intervals. Following this disease, the bacteria remain in the liver, spleen, and lymph nodes. Occasionally, as a result of stressors, the reactivation of the vector state may occur, leading to developing the disease. Immunity acquired during the disease is short-lasting and specific for the bacterial strain which caused it [2]. In 2006, 13 362 cases of salmonellosis were reported [11].

Significant activities in salmonellosis prophylaxis involve veterinary and sanitary control of animal-derived food and periodically performed tests for the vector state among meat processing workers and collective nutrition workers. Carcasses and internal organs of animals infected with salmonellosis are considered unfit for consumption [13].

Leptospirosis is an infectious disease which occurs worldwide, caused by spirochaetes of the genus *Leptospira*, encompassing about 200 serotypes, which were

classified as bacteria as late as 1988 [2]. In Poland, several cases of leptospirosis are reported annually [11]. The main reservoirs for the bacteria include: rodents, mice, rats, as well as domestic animals, especially dogs, cattle, and pigs. This disease is caused by infected animals and asymptomatic vectors who excrete the bacteria with their urine (occasionally up to 1 million in 1 mL), as well as with milk. Unhealed breaks in the skin and mucous membrane are the entry points for infections. Alternative modes of infection are also possible, by consuming food or water contaminated by an infected animal's urine, as well as via direct contact with an ill animal, and through insects and inhaling contaminated dust. Once the spirochaetes penetrate into an organism, leptospiremia occurs. Then, specific antibodies eliminate leptospirae from blood circulation and these are located in convoluted tubules and reproductive system cells [19]. They are very sensitive to high temperature: at 50–55°C they die within 30 minutes, and above 65°C almost immediately. The spirochaetes manifest a higher resistance to low temperatures, e.g., they survive at –4°C up to 26 days, and in frozen meat up to 15 days. *Leptospira* is especially sensitive to an acidic environment, pH 6.0 is critical for its survival. Horizontal person-to-person infection is not observed. The course of this disease in humans, as well as in animals may vary from asymptomatic to acute leading to death as a result of renal failure. Symptoms of leptospirosis include: fever, vomiting, headache, jaundice, muscle aches, poor well-being, cerebrospinal meningitis, pneumonia, and nephritics. Generally, recovery is possible. Infections caused by *L. interrogans* lead to developing jaundice after a few days, renal failure, cirrhosis; in such cases mortality may amount to 20%. In pregnant women, leptospirosis may lead to abortion or severe general infection of the newborn. Casual treatment involves administering antibiotics (penicillin, streptomycin) with simultaneous symptomatic treatment. People belonging to high-risk groups may be vaccinated to prevent infection [19].

Leptospirosis is not controlled ex officio, but in clinical cases carcasses and the internal organs of infected animals are considered unfit for consumption [13].

Botulism, also known as botulinis intoxication, is caused by anaerobe *Clostridium botulinum*. In unfavorable conditions, these bacteria produce spores which are resistant to external agents. In Poland, about 165 cases of intoxication are reported annually; in 1997, 3 cases in children aged 4 were reported and 7 cases in children aged 5–14; deaths were not reported [15]. *C. botulinum* spores survive cooking for 3–5 hours, and under pressure at 120°C they are alive for up to 5 minutes. In corpses, green fodder, and silage, they survive many months [13]. *C. botulinum* developing under anaerobic conditions can produce exotoxine which is one of the most powerful toxins for a human organism. Lethal dosage of this toxin is about 0.12 µg. It is released to the environment mainly after the bacterial autolysis. Infection is most frequently transmitted to humans via the alimentary tract, following the consumption of salted and preserved foods which were insufficiently thermally processed. In

Poland, the main source of infections (65%) is canned meat, including home-canned (20%) [15]. Infections via wounds are also possible [2]. The incubation period of this disease ranges from some to 14 days in animals; whereas in humans from some to 14 hours. In exceptional cases it is prolonged to 7 days. Botulinum toxin present in food penetrates from the alimentary tract into blood and blocks acetylcholine release, leading to the paralysis of cholinergic fibers. In the course of this disease, two sets of symptoms may be differentiated, namely, non-specific symptoms: nausea, vomiting, loose stool, stomach ache, dizziness, weakness, and specific symptoms: vision distortion, mydriasis or pupilloplegia, dry mouth and throat, drooping of both eyelids, hoarse voice, loss of voice, facial muscles paralysis, decreased peristalsis, retention of urine, and muscle weakness. In wound botulism, irrespective of the specific symptoms, increased body temperature, prolonged incubation period (up to 2 weeks) and no symptoms associated with the alimentary tract are observed. Death is caused by heart failure or respiratory muscle failure. Infant botulism is a very dangerous form of this disease. It was first described in 1976, and it refers to children up to 6 months of age [15]. The pathogenesis of this form of botulism is not entirely known. It is probably caused by *C. botulinum* spores which can, exceptionally, develop under the conditions occurring in the alimentary tract of infants, producing the toxin leading to the intoxication symptoms [15]. The major dietary reservoir is bee honey, thus in the USA an educational action has been organized concerning not adding honey to milk blends. In Europe, infant botulism associated with honey consumption accounts for 59.2% of cases [17]. Clinical symptoms of infant botulism include: decreased sucking ability, decreased muscle tone, hypotonia, lack of or decreased tendon reflexes, poor facial activity, respiratory difficulties, and constipation [2, 3, 17]. Symptomatic treatment is ordered, serum is commonly administered. However, only intravenous hyperimmune vaccine (Big-IV) used in the USA, which binds free toxin, may revolutionize infant treatment [3].

Because of producing a very powerful toxin and spores resistant to external agents, *C. botulinum* is classified as a biological weapon.

Borreliosis, also known as Lyme disease, is caused by the treponema *Borrelia burgdorferi* (less frequently *B. garinii*), whereas the vector is usually a tick belonging to the genus *Ixodes*, transmitting infection from human to human. A natural reservoir consists of small rodents; frequently the infection is also transmitted by deer. In Poland, borreliosis is most frequently transmitted by ticks [6, 20]. The regions which are most endangered are: Podlaskie Province, Zachodniopomorskie Province, Mazury and the region of Suwałki.

In order for the borreliosis infection to occur, a tick must remain on the skin for several hours. Then the number of transmitted bacteria is sufficient for developing the infection. The incubation period is 1–3 weeks, followed by an early stage characterized by circular skin rash called erythema migrans. Occasionally the erythema

involves the entire limb, is painful, and the patient feels weak and feverous. After 2–4 weeks this erythema disappears, usually with no subsequent consequences. It happens, however, that after this period, or even after 3 months, symptoms occur, such as: arthritis, neurological and cardiac disturbances.

Arthritis develops in untreated people in the early phase: it involves large joints, exudates are observed as well as synovitis. This disease should be differentiated from rheumatoid arthritis. Proper treatment is usually effective; however, cases of recurring arthralgia are known. Cerebrospinal meningitis, peripheral neuropathy and inflammation of peripheral nerves are serious complications, leading occasionally to physical disability, and in exceptional cases to death. Another serious complication is myocarditis, which may cause complete heart block and progressive cardiomyopathy.

In diagnosing borreliosis, serological and polymerase chain reaction (PCR) tests are used. The most effective prophylaxis involves vaccines; however, devising a vaccine in Europe is complicated by the fact that three etiological factors are found here. In the USA, where only one etiological factor occurs, a vaccine (LYMERix) is administered in endemic territories [1, 7]. In Poland, the Ministry of Health recommends the guidelines devised by the Polish Society of Epidemiologists and Contagious Diseases Physicians (Societas Polona Epidemiologorum et Medicorum Contagiosorum). Some physicians also propagate the method devised by the International Lyme and Associated Disease Society.

CONCLUSIONS

1. Prophylaxis is critical for controlling bacterial zoonoses. This is evidenced by the European Union (EU) directive concerning a requirement for annual reports on various zoonoses identified in the EU countries, and prepared by each member state.
2. Close cooperation of epidemiologists and specialists in epizootology is the key issue regarding efficient prophylaxis.
3. Societal education with respect to zoonoses will definitely contribute to their less frequent occurrence.

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